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EVERYWHERE the name of Spain is associated with the name of Columbus. In the Exposition, in front of the eastern door of the beautiful palace of administration, there is a statue of the great navigator waving the banner of Castile; on the pedestal is an inscription in Latin that many will not understand, by the Latin-Spanish poet Seneca, who, in his "Medea," said that "Thule was not the last of the lands." Seneca is the same poet and writer that our great historian, Bancroft, mentions as saying that "A ship leaving the western coast of Spain could reach in a few days, with favorable winds, the shores of India," and that doctrine was treasured and repeated by the great Aristotelian philosopher, the Arabic-Spanish Averroes. The union of Spain with the idea of discovery of new countries that were to complete the world even centuries before Columbus seems providential.

Those who have walked bewildered in the great Exposition have read the inscriptions in the friezes of the Administration building, recalling the glorious feats of Spain in the discovery, and in many buildings have seen the coat of arms of that old nation, especially in the beautiful palace of machinery and in the Casino and Peristyle. They have seen, also, or they have known, that on the first of May, when the glorious banner of the stars and stripes was raised amid the thundering hurrahs of the multitude, on both sides of it were raised, at the same time, the banner of Castile and the pennant of the Catholic kings with the green cross and the initials of Ferdinand and Isabella. Wandering through the park, they may also see the name of Spain everywhere in the Exposition without taking into account what the Spanish government has done.

The Convent of La Rabida is an exact and accurate reproduction of the monastery where Juan Perez, the good and learned prior, friend of Columbus, gave him shelter and comforted him until he succeeded in gaining for him the protection of the great queen.

California has erected a stately building for the products of that commonwealth, representing in its architecture the facades of four of the Spanish missions. Texas has done the same thing. Colorado has chosen the style of the Spanish Renaissance. Florida has reproduced the fort erected in 1620 by the Spaniards at St. Augustine, that claims to be the oldest building in North America.

All those States that one day belonged to Spain are proud of their origin and of their history, and have proved it, as well as have the architects of the Exposition, who have given evidence of good taste in deciding that one of the buildings should be constructed in the style left by the Spaniards on this continent, and choosing for that the beautiful Palace of Mechanic Arts, an artistic reproduction of the Cathedral of Puebla. And if the facts speak for Spain in the monuments of the Exposition, her name has not failed to be mentioned in words in the great ceremonies and festivities.

Vice-President Morton, who represented Mr. Harrison at the dedication, said: "New York was aided in the celebration by Spain, Italy, and France." In Hampton Roads the Spanish squadron was present, with the cruiser Reina Regente, the second in naval power; but even more interesting than the modern ships were the caravels, as a reproduction of the historical fleet. Nobody fortunate enough to have seen it could forget the scene on that day, when the Santa Maria, that had sailed alone through the ocean by the same route of Columbus, by the skill and courage of Commander Concas and his plucky mates, moved through the lines of the fleets of the world.

At the opening of the Exposition came, invited by the nation as its guest, the Duke of Veragua, descendant of the great navigator, and the American people could see and cheer the descendant of the discoverer, and the offspring of Columbus could feel proud of what in four centuries the continent where his ances-

HER EXCELLENCY SENORA ADELE DUPUY DE LOME, LADY COMMISSIONER FOR SPAIN.

tor brought the light of the Gospel and civilization has accomplished. Later came to America and visited the Fair, representing the kings of Spain and the descendants of Catholic kings, their royal highnesses the Infantes Eulalia and Antonio, who won so much popularity.

Spain has sent also the band of the Twelfth Infantry Regiment, whose music was admired by all who were fortunate enough to hear it. She has also had in Chicago a number of officers of the army to study the art of war, a large commission of mechanics of different trades to study the progess of industry; and not content with having sent the caravels to New York to the naval review, has made them take a most marvelous voyage by inland waters, and brought them to the Exposition after a trip of 9,000 miles, and has presented them to the government of the United States, which will keep them as a remembrance of the heroic feats and of the friendship of Spain. Finally we must add that, granting the request of the United States government, Spain has allowed to be sent to this country and placed on exhibition in La Rabida invaluable historical documents given to the care of Mr. W. E. Curtis, and guarded by United States soldiers, to be admired by thinkers and curiosity-seeking people. Among them is the original will of Queen Isabella, in which is the signature put there by that great woman when her soul was about to leave her body; this is one of the documents most appreciated and venerated in Spain. The letters of Columbus, his portraits, documents of the houses of Veragua and Alba, both descendants of the admiral, sailing charts of the first discoverers, all these, too, have been sent by Spain and can be admired in La Rabida.

When, in the last days of January of the present year, Mr. Dupuy de Lome, who was still Spanish minister at Washington, came to Chicago, announcing his appointment as royal commissioner general of Spain at the World's Fair, the hope that Spain would come to the Exposition had been nearly abandoned. All the nations were working with great activity. The greater part of the buildings of the States and of the foreign governments were nearly completed. All the nations had taken possession of the space which had been allotted to them in the different departments, and their work was far advanced. The commissioners were present in full force, and many of them had already been here two years, and others had already been working six months. A great will and a great deal of energy was necessary to keep pace with them, but neither was lacking in Mr. De Lome, and Spain was ready at the same time as the other nations.

The royal commission of Spain was completed by the appointment of Senor Don Augustin G. del Campillo as assistant commissioner general. This gentleman had already been in Chicago in the summer of 1892 and secured for Spain space in the different buildings when it seemed impossible to have it. Besides Mr. Campillo were appointed Don Rafael Puig y Valls, engineer, as a special commissioner of industry; Don Vicente Vera, also an engineer and medical doctor, special commissioner of agriculture; and Don Joaquin Pavia, architect, as special commissioner of fine arts. The department of war appointed Captain Don Juan Cologan, and the department of the navy Lieutenant Don Juan Ibarreta. The Chamber of Commerce of Havana, that was in charge of the exhibition of the Island of Cuba, sent Don Rosendo Fernandez, who was lately appointed special commissioner for the Spanish West Indies. The board of ladies, under the presidency of her majesty the Queen Regent, who had charge of the work of the women for the Exposition, appointed to represent it in Chicago the Duchess of Veragua and Senora Dupuy de Lome. These are the names of the persons who have superintended the Spanish exhibit, of which we will speak briefly, as space will not permit lengthy explanations.

THE SPANISH BUILDING.

The Spanish building is situated in the northeast end of the park, near the lake, on the same street with France, between the German and Canadian buildings, and is an exact reproduction of the Lonja de Valencia, Spain, and is one of the best and finest examples of Gothic art. The Lonja, or Merchants' Exchange, has been standing in Valencia since 1482, and is still devoted to its original purpose. It was built by Pedro Comte, and shows the advancement of the constructive art at the time of the discovery. The building at the Exposition is three-fourths of the original in size, and has been built under the direction of Rafael Guastavino, architect, of New York.

WOMAN'S BUILDING.

The booth of Spain in the Woman's building has the place of honor in front of the south entrance, and reproduces features of the famous cloister of San Juan de los Reyes, of Toledo. The structure is a fine specimen of Spanish style, and is suggestive of the position of woman in Spain. There is a bust of Queen Isabella, the ideal woman, who was a good mother, a housewife, and at the same time ruled over a kingdom, fought the enemies of her kingdom, and was the only one who understood Columbus. The legend "Tanto Monta," the motto of the Catholic kings, means that both queen and king are equal. In the eight medallions in the corners are the names of eight Spanish women, from the fifteenth century to the present time, celebrated as philosophers, historians, poetesses, and theologians.

In the Spanish section in the Woman's building, the work of women is very comprehensive. There are the products of the handicraft of poor fisherwomen and peasant women, the works of factory girls, embroideries made in schools and convents. The beautiful paintings and embroideries that are counted among the best in the building are made by the most gifted and fortunate women of Spain. Three large panels are devoted to paintings, and two show cases in the central court to ancient relics and works of the queen and princesses.

In the educational department there is an exhibit of the normal schools for women teachers and another from the college of governesses, and in the library there are 283 volumes written by women.

In the Children's building there is also a representation of Spanish toys, being a reproduction of the things made to teach and amuse the little ones during the Christmas period.

FINE ARTS.

It is always difficult to get a graphic representation of what is in the fine arts department at the Exposition, as there is not light enough to take comprehensive pictures, and the colors cannot be reproduced. Spain has three rooms that are too much filled with pictures, and there is no section in the art gallery, in the opinion of all the experts, where the standard of the pictures is so equal. All are good. It is said that the principal masters of Spain have not come to Chicago, but there is not a single picture that disgraces the Spanish department. We have no space to mention the pictures. The excellent catalogue of the Spanish section gives minute details of them.

In sculpture Spain is also well represented, and we are happy to reproduce some of the most interesting specimens. The jury of fine arts has not been just, in the opinion of the Spanish commissioner, to the Spanish section. The public will judge, by looking at some pictures in other sections that have received an award and then looking at many in the Spanish section that have none; that will decide if full justice has been done.

MINES AND MINING.

Spain presents in this section silver, quicksilver, iron, coal, lead, copper, marble, and salt, in sufficient quantities to give a good idea of the riches of her mines. The scientific part of the exhibit is represented by beautiful maps and collections of the commission for the geological map of Spain, and by a complete collection of the Escolapios of Guanabacoa, Cuba.

The island of Cuba, whose mineral wealth is now being exploited, and which has a great commerce with the United States, sends good specimens of her products. Metallurgy is represented by splendid specimens of the factories of Bilbao.

HIS EXCELLENCY DON ENRIQUE DUPUY DE LOME,
Royal Commissioner-General of Spain; President of Jury of Awards for Viticulture.

AGRICULTURE.

This department is one in which Spain is better represented, and the pavilion erected is the best and most artistic of the department. In this section are exhibited the products of Spain, Cuba, Porto Rico, and the Philippine Islands. It is also a specimen of Spanish architecture, being taken from the upper part of the court of the Convent of San Geronimo de Valladolid.

The Spanish section is divided into two principal parts. In one are the products of Cuba, foremost among which is the tobacco exhibit, in beautiful and rich show cases. There are very fine samples of liquors, cocoa, sugar, coffee, alcohol, and precious woods. In the other section Porto Rico exhibits her valuable coffee, the best in the world, also cocoa, sugar, liquors, jams, and jellies, and many other products of her industries and soil. The Philippine Islands have manila hemp, sugar and tobacco. Spain has cereals, macaroni, vermicelli, etc., sweets, chocolates, beer, cider, oils, olives, mineral waters, preserves and tobacco, giving an idea of the richness of the soil and industries.

MANUFACTURES.

The Spanish section in the department of manufactures occupies the space originally allotted to her, and besides all which was intended for Portugal, Servia, Greece, the Argentine Republic, Ecuador, and Venezuela. The defects of the space have been remedied by a happy reproduction of the mosque that is now the Cathedral of Cordova, and which stands in that city of Spain and is more than 1,000 years old.

The representation of Spain in the Manufactures building, although not completely in accordance with the great progress made in that country in the last years, is fine and important. The wool industry is represented by large specimens, some of which from Sabadell and Tarrasa we are informed have been judged by the jurors as second only to the products exhibited by England. The cotton industry has also merited a first award, and some of the product has been declared second to none. Besides there are velvets, silks, paper, leather, hemp, shoes, wrought iron in artistic forms, china and pottery, furniture, of which is presented one of the finest specimens of carved work that is at the Exposition. The product of an industry that is particularly Spanish is that of inlaid work of gold in steel, of which there are two vases valued respectively at $40,000 and $20,000, that are the marvel of the department.

The Spanish section in the department of transportation is divided into three different parts. One is devoted to the exhibits of the war department, where can be seen models sent by the royal engineers of the modern defenses of Spain, and at the same place waterworks from Cuba and the old castle of San Juan de Ulloa, in Vera Cruz, Mexico, as an example of what the Spaniards did in that country. There are also beautiful specimens of the swords made in the famous manufactory of Toledo, among them the duplicate of the swords of Queen Isabella, Hernan Cortez, etc., a great number of guns, showing a history of the artillery in use in Spain from the ancient to the modern times.

The second section is devoted to the exhibit of the naval department, that has models of ships and artillery, canvas for sails, ropes, etc.

The third section has a beautiful exhibit of the Spanish Transatlantic Steamship Company, with models of ships, docks, factories, plans of the route of the different lines, and all that can give a good idea of its importance.

MACHINERY.

The Spanish section in this department is not very important. Only the firms of Escuder y Castella and Valls have sent some very interesting specimens of work from their factory, comprising several different types of machines and implements.

VITICULTURE.

The Spanish section of viticulture is very important. Spain has more than twenty times the space that was given to her originally, and even with that has not had enough room to put all the wines that have been sent from over the sea.

The main section is situated in the southeast pavilion in the Horticultural building. Entering the section from the central dome, by the curtain full of tropical plants and flowers is a large archway composed of nine different arches, in the beautiful Moresque style of the Alhambra, that forms the entrance to the Spanish section.

There are probably 10,000 different kinds of wine sent by more than 2,000 exhibitors. From the costly sherry over 100 years old to the common claret, sound and healthy, drank by the peasants, and that can be retailed at about one cent a bottle, there are numerous specimens of the product of the vine in Spain, and the products of her soil. It is not generally known that Spain has such a large wine production and can export more than five times as much as France. The arrangement of the section is very tasteful, and the

wines are put together by regions and provinces; some in counters and pyramids made in Chicago, others in costly cabinets sent from Spain. Besides the main section there is one devoted to the brandies of the style of Cognac. Since the loss of the vineyards in France the distillation of wine for brandies has been greatly developed, and commerce will have to go to Spain for the genuine product.

There is also another Spanish section in the gallery. Going through the staircase, that has been adorned by Spain with a dome made of bottles, there is an exhibit of cordials with many important specimens, principally of the Spanish "anisette," which is the national beverage. The wine exhibit of Spain is by far the largest and most important of the whole department.

FORESTRY.

In the Forestry building the space of Spain is occupied by a very fine exhibit of woods from the Philippine Islands, a collection of the woods of Cuba, showing the riches of the island; among them three large logs of mahogany that have been considered as one of the wonders of the department. Porto Rico also contributes some fine specimens of wood, and Spain, with her celebrated cork, of which so much is imported by the United States.

A JAVANESE THEATER.

OF the many foreign theaters in the Midway which have been the cause of so much complaint from the lady managers of the Fair on account of the indecent sights to be witnessed within, there is one, at least, which may well be excluded from this just censure. The theater of which I speak is situated in the Javanese settlement, and there is no other theater on the Plaisance where one can spend a more pleasurable or instructive three-quarters of an hour than in this lightly built playhouse.

Upon passing within its bamboo walls one sees at the further end of the room a stage, on the back of which are some benches placed on an incline, and seating about twenty-five musicians. Behind these benches is a background of Javanese scenery, painted by a native artist, which is quite remarkable for the good perspective it contains. Along the sides of the stage are strung some curious wooden puppets dressed to imitate the actors. These figures were originally intended for marionette performances, but since that style of entertainment is no longer in vogue, the actors now use them as mascots. When one does well his puppet is placed on the right hand side of the stage, but if, on the other hand, his acting does not come up to the standard, his miniature likeness is hung in disgrace on the left.

The instruments used by the musicians were very curious, and consisted chiefly of bells, ornamented metallic jars and various sized metallic gongs. Two of these last named instruments were immense. They hung from slender metal supports placed on the highest bench in the orchestra, and were occasionally beaten by an aged musician who sat between them. The larger of the two is said by experts to produce as deep a tone as it is possible to get from metal.

The orchestra was led by a pleasant-faced old musician, who sat on one of the front benches and played away on a two-stringed fiddle. No notes were used, as they played wholly by air, keeping time and tune as best they might by now and then glancing at the leader. The music thus produced was quite harmonious, and did not have that wild discord peculiar to some of the other theaters.

The first part of the programme was a dance by five pretty young girls. They entered from either side, arrayed in white stockings, but without slippers, bright colored velvet knee breeches and embroidered bodices, leaving the arms and shoulders bare. From the waist hung so many sash ends as to produce the effect of skirts. The dance consisted in sliding very carefully into some exceedingly strange poses, in which the girls stood with feet far apart and arms outstretched, whisking the ends of their sashes back and forth over their wrists, and gazing intently at their fingers, which they kept bent upward in an exceedingly difficult position. The dance being concluded, the girls retired, only to reappear several minutes later dressed for the play. But a short extract of this could be given, as it would take sixty hours to perform the whole piece. The part which we saw was very interesting, and gave the actors ample opportunity to show their talent. Not till well on in the play did I discover that the dialogue was being carried on by a man concealed behind an innocent-looking screen directly in front of the orchestra. And even then it was hard to believe that the actors were not carrying on the conversation beneath the masks which covered their faces, so well were the gestures brought in.

The play was supposed to represent the victory of light over darkness, or of good over evil; and the good man and his doings could easily be distinguished from the evil one. The evil one was represented as a man enveloped in a reddish-hued, gilt-embroidered cloak, carrying a dagger, and having a very hideous face, with two little tusks projecting downward from the corners of the mouth. He capered about pretty briskly, flourishing his dagger now and then, and showing by his actions that he was bound on no good intent. The good one wore a plain gray cloak, together with a much plainer mask than that used by his wicked rival. He was quiet and unassuming in his manner, but emphasized his words once in while by a backward movement of the thumb, which means the same as our shaking the forefinger.

These two men were having a squabble over a pretty girl, who seemed to favor the good one; and, could the play have been finished, doubtless he would have conquered.

In conclusion the girls entered dressed as in the first part, with the addition of fancy gilded wings and helmets. They sang a short operetta in their native tongue, and seemed to enter well into the spirit of the piece. Their voices were rather shrill when used at their highest compass, but when rendering the lower notes sounded soft and melodious.

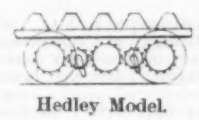
As a grand finale the orchestra struck up "Yankee Doodle," and rendered it so well as to make every American applaud vociferously. For an encore, "America" was played, and I was greatly surprised at the good time and tune they kept. It is needless to say that I came out of the theater with my estimation of the Javanese people raised a hundred per cent. Not till one witnesses their most interesting performance does he fully realize what an ingenious and artistic little people they are. S. Y. B.

THE EXHIBIT OF THE BALTIMORE & OHIO RAILROAD AT CHICAGO.

By JOHN C. TRAUTWINE, Jr., C.E.

THE colossal exhibit of the Baltimore & Ohio Railroad at Chicago forms quite as radical a departure from recognized methods as does that of the Pennsylvania Railroad (see *Railroad Gazette* of October 13), but it is also as different as possible from the latter. Not only are the two exhibits utterly unlike in the

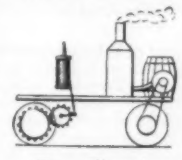
Stourbridge Lion.



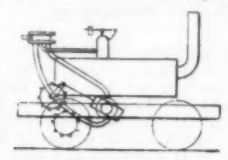
Hedley Model.

character and arrangement of the objects shown; they differ vitally in their dominant ideas. While the Pennsylvania, in illustrating the subject of railroading, has confined itself almost exclusively to the use of its own plant, the Baltimore & Ohio has availed itself chiefly of examples derived from the practice of other corporations.

To prepare an exhibit that shall worthily illustrate "The World's Railway: Its Evolution and Development," is a task of unusual magnitude. Yet such is the problem to which the Baltimore & Ohio Railroad Co., at the suggestion and under the direction of Major J. G. Pangborn, its Exposition executive, has devoted itself and which it has solved in grand style. In this work Major Pangborn has had at command the valuable services of Mr. Ransom C. Wright, mechanical expert.



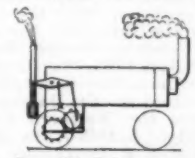
Tom Thumb.



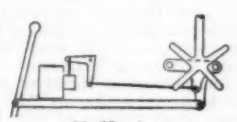
Costello.

The attention of every visitor to that portion of the Transportation building annex where the company's exhibit is placed must infallibly be attracted by the magnificent display of fifty-odd full-size locomotives, either actual engines or exceedingly faithful wooden reproductions, arranged in three rows, each nearly 475 ft. long, which form the principal and by far the most prominent portion of this great display.

This series, illustrating the evolution and development of the locomotive, begins with Newton's idea of a vehicle working by relief pressure and without other moving machinery than its wheels, and embracing no less than 54 specimens in all, arranged in strict chronological order, leads up to two great engines, simple and compound respectively, built for the company by



Geo. W. Johnson.

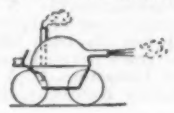


V. Hook.

the Baldwin Locomotive Works during the current year.

Following the Newton comes the Cugnot, a three-wheeled vehicle, designed for carrying artillery and used to some extent for that purpose in the streets of Paris, in which city the original machine is still preserved. The front wheel was used for guiding the machine and carried the entire weight of the boiler and engine, the latter consisting of two vertical single-acting cylinders.

Further on we come to a reproduction of the Oruktor Amphibolis, the remarkable machine, half locomotive, half boat, constructed by Oliver Evans at his shop in Philadelphia in 1804, and run by steam power through the streets of that city to the Schuylkill River, which it navigated to its mouth, whence it is said to have ascended the Delaware to a point where it was set to work dredging. Whatever advances the



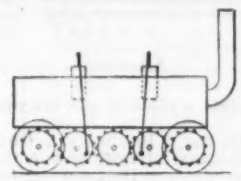
Newton.

Cugnot.

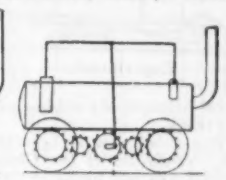
locomotive builder may have made up to the present time, it certainly is not usual to find locomotives of modern manufacture that can swim and dredge. This strange fabrication is said to have weighed 40,000 lb. Its boiler was bricked in, and the engines operated upon one pair of wheels, and these upon the other pair by means of rope gearing.

Then there is Trevithick's audacious Catch-me-who-can, which could no doubt be caught easily enough nowadays, and Brunton's mechanical traveler or horse-leg locomotive of 1813, with its posterior appendages which pushed backward along the road and so propelled the machine; the Hedley model, constructed to demonstrate the possibility of moving an engine upon smooth wheels by virtue of its "adhesion," and the Puffing Billy, constructed by Hedley shortly after, and containing the embodiment of the proposition here established; the Blucher, Stephenson's first engine, 1814; Stephenson's Rocket, which won the prize in the Liverpool and Manchester competition; Timothy Hackworth's Sans Pareil of 1829; Braithwaite and Ericsson's Novelty, which also competed in the Liverpool trial; and the Stourbridge Lion, "the first actual locomotive seen in America," and "the first to run upon rails in America."

In the second row we find, among others, Peter Cooper's Tom Thumb, "the first locomotive built, and the first to draw a car on the American continent," and which made its first trip on the Baltimore & Ohio Railroad. Here, too, are reproductions of the five engines which entered the Baltimore & Ohio competition of 1831, each different from the others, and none of them resembling any foreign engine. These were built respectively by George W. Johnston, of New York; by Davis & Gardner, of York, Pa.; by Stacey Costello,



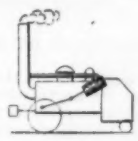
Blucher.



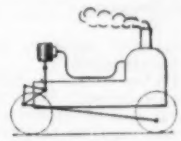
Puffing Billy.

of Philadelphia; by Ezra Child, of Philadelphia, and by William T. James, of New York. The Johnston was "the first engine in the world with a double fire box," the Costello had a Galloway boiler and oscillating cylinders; the Child is "believed to be the only rotary locomotive ever successfully used on rails," and the James had a double gearing, so that the engine could be worked either for speed or for power, as might be desired. The York, however, which mechanically seems the most vicious of all, took the prize. Here the connecting rods from the vertical cylinders acted at the center of a horizontal trussed beam which bore at its ends upon the cranks of the two pairs of driving wheels.

The first actual engine which we meet in the collection is an old "grasshopper," the Atlantic. Gazing at



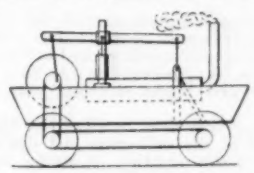
Rocket.



Novelty.

its large vertical boiler, its vertical cylinders working upon its single pair of drivers, through overhead horizontal levers and a set of cogwheels, it seems almost impossible to believe that this aged machine, placed upon the Baltimore & Ohio Railroad in 1832, has continued in actual service there until within a few months, when it was taken from the rails only in order that it might be exhibited here.

Next to the Atlantic is a reproduction of M. W. Baldwin's first locomotive, the Old Ironsides, built in 1832 for the Philadelphia, Germantown & Norristown Railroad, and then comes Horatio Allen's strange-looking double ender, the South Carolina of 1832, "the first eight-wheeled engine in the world;" "the first locomotive in the world with a horizontal double boiler," and "father of the Fairlie type."

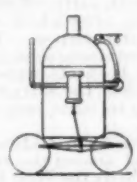


Oruktor Amphibolis.

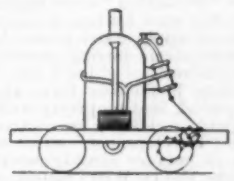
Catch Me Who Can.

Next to this is another historical specimen, John B. Jervis' Experiment of 1832, "the first locomotive in the world with a bogie or forward truck." The Traveler and the Jefferson are other ancient and actual examples of the grasshopper type, while the Mazeppa is a "crab," *i. e.*, the grasshopper in all but the essentials, the vertical cylinders with their overhead levers being replaced by horizontal cylinders.

Among these stands Henry R. Campbell's engine of 1837, "the first American eight-wheel locomotive," and a little further down the aisle is Eastwick and Harrison's Hercules of the same year, "the first locomotive



York I.



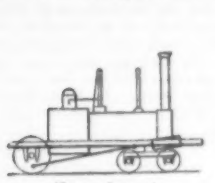
York II.

in the world with equalizing levers," closely followed by Norris' Lafayette, "the first six-wheeled engine on the Baltimore & Ohio."

The third row begins with the Sandusky of 1837, "the first Rogers, the first locomotive to run west of the Ohio River, and the first American counterbalanced locomotive." Near this is the bruised and battered Samson, built by Timothy Hackworth in 1838, used in Nova Scotia for forty-odd years, and barely saved from destruction. Following this relic is the ancient carriage which was sent over from England with it, and which could probably hold as many as ten persons at a pinch. Then comes the Albion, also by Hackworth, with a wire bucket suspended in front of the chimney, to hold blazing pine knots in lieu of a proper headlight; Ross Winans' Buffalo, the first eight-wheeled coupled engine (Mud-digger) in the world, and a little further on, Winans' "first camel back;" Baldwin's Dragon, placed on the Baltimore & Ohio in 1848, taken from work for exhibition, and to be returned to

work after the Fair; and, still further on, "the first locomotive of the ten-wheel camel type."

The Mason, of 1853, reminds us of the gorgeously tinted structures that moved upon our railroads in those days, and is immediately followed by the Peppersauce, "the first mountain climber in the world," built for the Mount Washington Railway in 1863, with its vertical boiler suspended from trunnions and standing,



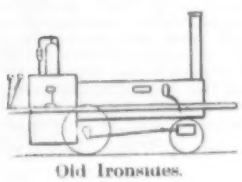
Experiment.

Atlantic.

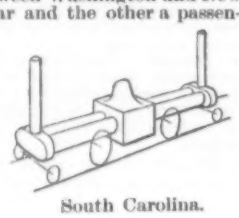
"the original old engine upon a piece of the original old track."

The third row ends with the "Baltimore & Ohio 600," exhibited at the Centennial of 1876, and in the fourth row we find the two modern Baldwin engines just built for this road from designs by Mr. G. B. Hazlehurst, general superintendent of motive power for the Baltimore & Ohio, besides which the exhibit of the Baldwin Locomotive Works contains a ten-wheel freight engine built by them for the Baltimore & Ohio.

This row contains also two day coaches of the company's Royal Blue Line between Washington and New York, one a combination car and the other a passen-



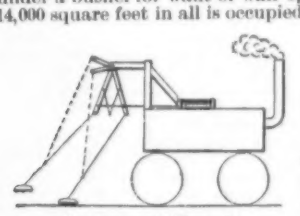
Old Ironsides.



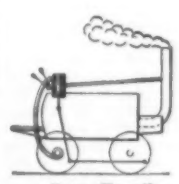
South Carolina.

ger coach, with smoking compartment at one end. Both are vestibuled.

Less striking to the average visitor than the collection of locomotives, yet in some respects equaling it in interest, and of course greatly surpassing it in respect to the number and variety of objects contained, is the collection of photographic and other views, of which about 1,700 are exhibited, while over 600 remain under a bushel for want of wall space, although some 14,000 square feet in all is occupied.



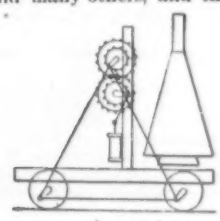
Mechanical Traveler.



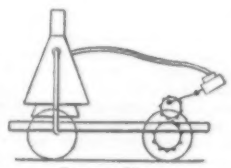
Sans Pareil.

Most prominent, perhaps, in this part of the exhibit are two series of wash drawings, measuring 30 × 30 in., illustrating the evolution and development of the locomotive, the "evolution" extending down to that time when the locomotive first began drawing cars upon public railroads.

These two groups portray most or all of the historical engines displayed in the collection just described and many others, and the addition of living figures



James I.



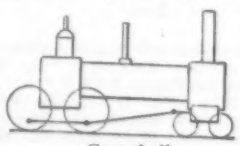
James II.

in the pictures adds greatly to their interest. The drawings are of unusual artistic merit.

The "Evolution" series begins with early efforts to utilize the wind for land locomotion, after which come efforts to apply hand power for the purpose. Then comes the steam-carriage period, containing some peculiar monstrosities which it has not been attempted to reproduce in the solid form, and then the early tramway period, leading pretty well up to what may with propriety be called a locomotive.

The "Development" series contains, in addition to views of engines already described among the reproductions, the De Witt Clinton, made by the West Point

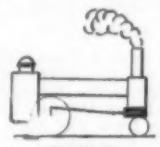
Trevithick.



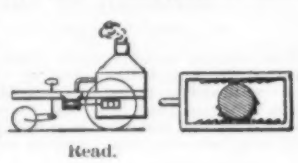
Campbell.

foundry in 1831; Stephenson's Patentee of 1833, "upon which was used the first steam brake;" Norris' Washington, which climbed the Belmont Plane at Philadelphia, and many other engines of the greatest historical and technical interest. Among more modern engines it embraces the original Consolidation, designed by Alex. Mitchell and built by Baldwins in 1866; the first Decapods (the Ant and the Bee) of 1867, and a large number of modern compounds of many different designs, and ends with the Wright, the compound patented by Mr. Ransom C. Wright, mechanical expert of the exhibit, with high and low pressure cylinders on each side, working on a vertical walking beam. A series of 136 wash drawings illustrates the development of permanent way and track, beginning with simple wooden stringers of the seventeenth century, embracing a large number of more or less practical devices and ending with metal ties and sleepers of modern invention.

About the only portion of the entire exhibit which may be said to be exclusively "B. & O." is a series of 77 large and handsome bromide enlargements, illustrat-



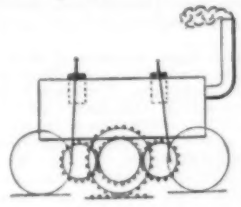
Mercury.



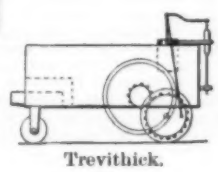
Read.

ing "Picturesque B. & O.," beginning with the view of Lake Michigan at Chicago and ending with the Statue of Liberty in New York harbor. Pittsburg, Washington, Harper's Ferry and Locust Point, Baltimore, are here represented upon a very large scale.

A very important collection, unfortunately crowded out of the main body of the exhibit, is a series of some 70 large drawings, with a few prints of early and recent American bridges, prepared and contributed by Mr. Theodore Cooper, of New York (who, however, has modestly withheld all trace of his name), and very ad-

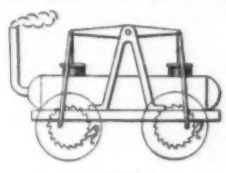


Blenkinsop.

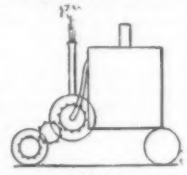


Trevithick.

mirably illustrating the development of bridge construction in this country. One of the oldest bridges here shown, if not the very oldest, is the Trenton bridge, built by Theodore Burr in 1804, and only removed some 15 years ago. The collection includes also the Baltimore & Ohio Railroad bridge at Harper's Ferry, designed by Benj. H. Latrobe and built by Lewis Wernwag in 1836; the Howe truss over the Connecticut at Springfield, Mass., built by Wm. Howe in 1838; Pennsylvania Railroad bridge over the Susquehanna at Rockville, Pa., J. Edgar Thompson, chief engineer, 1848–9; the Erie Rail-

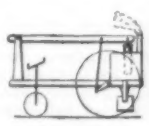


Howard.

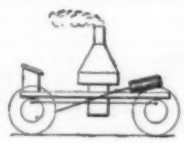


Child.

way bridge over the East Branch of the Susquehanna, Julius W. Adams, resident engineer, 1849; the McCallum truss at Lanesboro on the Erie, 1851; the old and new Portage viaducts; Columbia bridge (Burr truss) over the Schuylkill at Philadelphia, 1832; Long's truss bridges of 1833 and 1837; the earliest boiler plate girder bridge, as originally erected on the Baltimore & Susquehanna Railroad (now the Northern Central Railway) by James Millholland in 1846-7; the iron Howe truss bridge of the Boston & Providence at Springfield, Mass., 1849; the Brandywine Creek bridge of the Erie, designed and built by Squire Whipple in 1848; Town's lattice over the Hudson, at Troy,

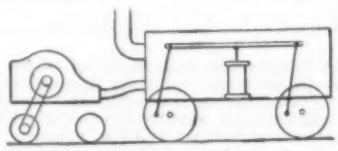


Murdock.



Best Friend.

1851; the great Cascade Glen wooden arch on the Erie, designed by Julius W. Adams, 1848; the Niagara suspension bridge, Roebling, 1852–3; the Victoria tubular bridge, Montreal, 1854–9; the Bollman bridge of the Baltimore & Ohio at Harper's Ferry, 1852; Fink bridges on the Baltimore & Ohio; the first Post's truss bridge at South Washingtonville, N. Y., built by S. S. Post, 1865; the channel span of the Steubenville bridge, designed by J. H. Linville, built 1863–4; the New York Central double track riveted lattice bridge over the Erie Canal at Canastota, N. Y., as originally built; C. Shaler Smith's Kentucky River



Seguin.

cantilever bridge, 1876–7; Mr. Morison's recent Alton, Bellefontaine, Memphis and Cairo bridges, the Kinzua viaduct; the Pecos River viaduct, by Phœnix Bridge Company, 1891, and many others.

At this writing Mr. Cooper's exceedingly valuable exhibit is very difficult to find, not only from its being placed in the gallery of the Transportation building proper, while the main portion of the Baltimore & Ohio display is on the ground floor of the Annex, but also from its being without any distinguishing label or any sign to indicate its connection with the Baltimore & Ohio collection. We are assured, however, that this unfortunate state of affairs will at once be remedied.

A series of 29 wash drawings is devoted to the illustration of the evolution and development of the power brake, from the very crude forms applied to ordinary carts in the 17th century to the modern systems of the Westinghouse, American and Smith companies. It embraces Stephenson's first locomotive steam brake of 1833, and shows some very interesting intermediate forms of spring and chain brakes.

Seven maps of the United States, one for each decade from 1830 to 1890, show the development of the railroad system in this country. The remarkable features in this series are the relative density of the northeastern quarter of the country, and the extension of the railroad to the Pacific in the decade between 1860 and 1870.

Twenty-four large and very handsome bromide enlargements, presented by Messrs. Neilson & Co., of the Hyde Park Locomotive Works, Scotland, show many designs of locomotives furnished by those works and form a fine addition to the exhibit.

Besides the different series thus briefly enumerated there is a vast array of miscellaneous pictures, embracing drawings by many very celebrated men, old time lithographs of locomotives, some of them resplendent in all the colors of the rainbow, views of American and foreign railways, embracing India, Palestine, Japan, etc., and showing not only the character of the countries passed through, but also, and in a very interesting manner, the forms of railroad structures there erected.

Here, too, is an excellent oil painting, measuring about 4 by 9 ft., by Edward L. Henry, of New York, painted during the present year, and representing a scene upon the old Mohawk & Hudson road when the De Witt Clinton was making its first trip with its train of tiny coaches.

Happily it is intended that this great exhibit shall not be resolved into the scattered condition from which it sprang, but shall be preserved intact in a proper building. One of the saddest things about this World's Fair is the impossibility of its indefinite continuance, coupled with the feeling that one cannot properly assimilate more than the minutest fraction of it, even if one could spend here the entire six months in its exclusive study. It is therefore especially gratifying to know that this, which is claimed to be the largest single exhibit in the entire Fair, will be properly cared for.—*Railroad Gazette.*

VARIABLE POWER GEAR FOR LOCOMOTIVES AND CARS.

By ED. C. DE SEGUNDO, A.M. Inst. C.E.

THE papers contributed to Section G of the British Association at the recent meeting at Nottingham were, says *Industries*, perhaps, unusually interesting as dealing with the application of mechanical science to practice, but, with two exceptions, these papers were of a purely descriptive nature. The two exceptions were contributions from Mr. W. Worby Beaumont, on "The Automatic Balance of Reciprocating Mechanism," and on "A New Form of Variable Power Gear for Electric Locomotives and Tram Cars." Both these papers bear the impress of long-continued, original research, and reflect very highly upon the individuality and ingenuity of their author. Both papers in their respective directions are of value, the first named for its suggestive nature, the second for its applicability to the requirements of everyday practice, and as the first paper has already been noticed at some length in a previous issue of this journal, it will only be necessary to refer here to the one whose title forms that of this article. It must be understood that the gear shown in the accompanying illustrations is improved in many important details upon that shown by Mr. Beaumont some time ago.

The value of such an apparatus is unquestionably very great indeed. Experience gained in the working of the City and South London Electric Railway shows the enormous increase in the power required in starting a train. This increase of power is due to the necessarily slow speed of the motor at starting, occasioned by the inertia of the train. A little reflection will show how adversely all the conditions of working are affected by this occasional increase of power, which, be it remembered, is found to vary from 25 to 50 and even 60 per cent. greater than the power necessary to run the train. The engine power at the generating station must, in the first instance, be increased, which in itself means extra outlay for boilers, buildings, and accessories. Then this unavoidable increase of power at starting has to be allowed for in the mains, thus adding to their size and also to the original capital outlay to an extent which would vary with the distance apart of the generating centers or of the feeding points, but would in any case be a considerable extent. Apart from these and other considerations, the effect on the lights in the trains should not be forgotten. Those who have traveled on the South London Railway say that the only objection they can find to electric railways is the continual bobbing of the lights. If the bobbing is very serious passengers will prefer some other route, and this might eventually bring about a decrease in the receipts from passengers which a company could not afford to overlook. Mr. J. H. Greathead has shown that if this increase of power at starting could be avoided, about 20 or 30 per cent. of the engine power which it is now found necessary to keep running might be dispensed with. This in itself would be a source of great economy.

The nature of the problem which Mr. Beaumont set himself to solve some three years ago possesses features of considerable complexity. It is quite a simple matter to understand what is required, but it is not so easy to determine at first sight upon what lines and in what direction one's inventive faculties must be exercised to bring about the desired result. In order to produce a variable power gear for electromotive purposes, it is essential that all forms of mechanical or electrical devices liable to become deranged or to wear unduly under the conditions obtaining in practice must be avoided, or if this is not always possible, at least reduced to a minimum. The mechanism must be capable of being thrown in and out of gear without risk of damaging any of the component parts. It must be easily operated by one having no technical training. It must be simple and of ample strength.

These requirements are absolutely essential for successful working in practice, and these conditions are embodied, as far as can be judged in the absence of practical experience, in the mechanism shown herewith. Figs. 1, 2, and 3 represent the application of the gear to tram cars.

Referring to Figs. 1 and 2, A is the motor spindle, C A the car axle to which motion is transmitted by the toothed wheels J and J¹. On the armature spindle, A, an eccentric, D, is keyed. This eccentric works inside a toothed wheel, E, which, with the toothed wheel, F, form an epicycloidal reducing wheel train. B, an electro-magnet keyed to the armature spindle, forms with C, its armature, an electro-magnetic clutch. C, J, and F are bolted together, so as to form one piece.

The toothed wheel, E, has cast on it a fork or horn block, E¹, the horns of which are guided by the pin, P, which is fixed in a ring, G, slipped over the annular wheel, F, and free to slide on it when its motion is not otherwise constrained. The outside of G is grooved, and the brake strap, H, is fitted on it, to one end of which is attached the rod, R, sliding through a guide, S, forged on to the other end of the brake strap, and terminating in a handle under the control of the driver.

When the brake strap, H, is slack, the motor spindle in rotating carries with it the eccentric, D, and the electro-magnet, B (which is taken to be demagnetized and about $\frac{1}{16}$ in. from the armature or keeper, C). The motions of E, F, G are not constrained relatively to each other, thus the rotation of A does not under the above conditions exert any driving power upon the car axle; in other words, the motor can run idle upon the axle.

Now imagine the brake strap rod, R, to be pulled in the right-hand direction (Fig. 2). The strap, H, is thereby tightened on G to the extent of causing the ring, G, to stop rotating or sliding on F, and also making it (G) stationary relatively to the car. This fixes the pin, P, relatively to the car, and consequently the action of the horn block transforms E into a driving wheel. Hence F is rotated in a speed ratio depending upon the relation of D to F, and J works the tooth wheel, J¹, on the car axle.

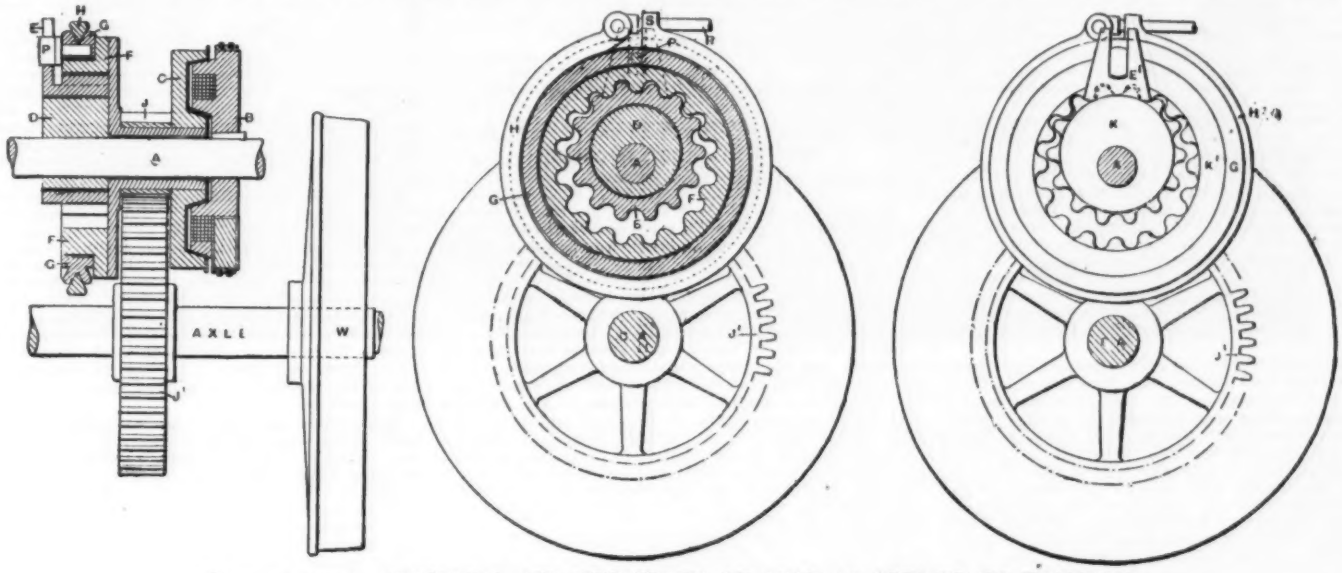
B and D are now rotating at the speed of the armature shaft; E has a motion similar to that of a connecting rod, and drives F. F, J and C are rotating at the decreased speed due to the speed ratio designed.

This is the condition of things when the car is being started, and it is easily seen that if the acceleration given to the car in the first second or two is not of vital importance (which may certainly be assumed in the very large majority of instances where such mechanism as this would be used), the power required to start the car need not exceed that required to drive it, and Mr. Greathead's 20 per cent. to 30 per cent. economy would be realized, and the "worst possible case" which has to be allowed for in designed electric railway conductors would be that of all cars *traveling* at once instead of, as at present, all cars *starting* at once. The vast importance of this will appeal to all who have had any experience in designing a system of conductors for electric traction.

Now the third operation for which this mechanism is designed is to throw the mechanism into "direct driving gear." This is performed in the following very simple manner: The brake strap, H, is slacked, and immediately after the clutch, B, is operated. This locks the whole mechanism, and drives J at the speed of the armature spindle. The clutch, B, has been shown as operated by electricity, but either this type of clutch or a clutch operated by fluid pressure may be employed. Mr. Beaumont has also devised a means of applying this principle to electric locomotives.

It may be urged that gearing could serve the purpose effected by Mr. Beaumont's mechanism equally well, and that if it is possible to make epicycloidal gearing work as well as is required for the apparatus, it is also possible to make wheel teeth as nearly perfect as may be requisite. This may or may not be the case, but the great advantage of Mr. Beaumont's design is that the gearing is only in action for the minute or so that the car is being started, and that when running the epicycloidal gearing is locked and there is no motion, and consequently no wear.

It is probable that experience in practice may dictate some modification of mechanical detail, but the gear is so well thought out and should supply—to use a well-worn phrase—so long-felt a want that one can only express the hope that the opportunity of applying it to practice may not be long delayed.



FIGS. 1, 2, AND 3.—SECTIONAL AND END VIEWS OF GEAR AS APPLIED TO TRAMCARS.

VARIABLE POWER GEAR FOR LOCOMOTIVES AND CARS.

THE MISSISSIPPI RIVER.

THE GOVERNMENT WORKS AN INJURY AND AN OBSTRUCTION TO THE FATHER OF WATERS.

I.

THE government works for improving the Mississippi River have reached a stage of experiment where their effect can be fully determined. It shall be proved from data furnished by the river in the rise of 1892 and 1893, that these government works are dams and hold back the waters of the Mississippi. When this action of the river as an effect of these works shall be established, the system that is in vogue to improve the Mississippi will slip into condemnation of all scientific and reasonable men. Common sense revolts from the attempt to dam the Mississippi. The volume of this river is too enormous to admit of its obstruction or detention in flow. The primal object is, or should be, to establish complete free discharge of the mighty volume. The question of a navigable channel will then be next in order for solution. Both of these inestimable results will yet be effected, but by the application only of sound principles in methods of construction. The present system of improving the Mississippi is a blunder, beyond question.

On April 5, 1892, the Mississippi at New Orleans rose to the height known as danger point. At all other stations on the Mississippi the water had not yet approached the danger point, or a stage of water anywhere near it. The great tributaries were low. Red and Arkansas rivers were low; the mean stage below the danger point for the month of March, being eighteen and three-tenths feet at Shreveport and ten and one-tenth feet at Little Rock. These rivers remained low and much below danger point until after the 15th of May—forty days after the Mississippi, at New Orleans, touched danger point. The Ohio, at Cincinnati, had not yet risen; the mean stage at this station for March being nineteen and five-tenths feet below danger point. The Missouri and Upper Mississippi were low and had not given indication of flood rise.

It takes a rise or flood wave twelve days to travel from Cairo to New Orleans. It is seen that the stage at New Orleans was at danger point on April 5. Deducting twelve days for the interval of travel, it is found that on March 24, 1892, the stage at Cairo was twelve and eight-tenths feet below danger point; while the mean stage for the twenty-four days of March was thirteen and nine-tenths feet below danger point. The waters represented by the above figures are the only waters from or passing Cairo that could possibly have reached New Orleans on April 5, 1892. These facts are incontrovertible.

Here then is presented this most anomalous condition: a dangerous flood beginning in the Mississippi below, near its mouth, while yet no dangerous flood had appeared at any station elsewhere in the river or in any great tributary. There was no natural cause for this unprecedented and dangerous high water. The condition was artificial; it was imposed upon the river by experimental and unscientific constructions. It was the refluence of waters, caused by the jetties in the mouths of the Mississippi and by the spur dikes in the channel at New Orleans. No other cause can be found under the heavens for the dangerous high water condition at New Orleans on April 5, 1892.

The flood of 1884 was the highest at Cincinnati, Cairo, Vicksburg, and New Orleans. It is a fact well known, that the waters coming out of the Ohio cause highest floods in the Mississippi below Cairo.

Compare now the rise of 1892 with the great flood of 1884. On April 28, 1892, the Mississippi at New Orleans rose to the high mark of 1884. At other stations on the Mississippi the water did not at any time approach the high mark of 1884, or a mark anywhere near the flood of that year. On April 28, 1892, Red and Arkansas rivers were low; flood rise had not appeared in these rivers. The Upper Mississippi and Missouri rivers were low, flood rise had not set in. The stage at St. Louis had remained below danger point until after the 11th of May. The Ohio River at Cincinnati was remarkably low during the month of March. The mean stage for the month of April was forty and one-tenth feet below the flood mark of 1884.

Deducting now twelve days as before, the time occupied in travel of water from Cairo to New Orleans, it is found that on April 16, 1892, the stage at Cairo was six and two-tenths feet below the flood mark of 1884; while the mean stage at Cairo for the sixteen days of April was nine and one-tenth feet below the mark of 1884. This stage at Cairo, shown by these figures, so greatly below the flood mark of 1884, represents the only volume of water from and passing Cairo that could have reached or could have been appreciable to the gauge at New Orleans on April 28, 1892.

This unprecedented accumulation of waters at New Orleans, when the river above is in moderate stage and its great tributaries low, is unmistakable evidence that the Mississippi is dammed; that its waters are held back and cannot discharge freely into the gulf. Here is a great flood beginning below; a river full of water to the highest mark, with no adequate rise from above, as has been clearly shown, to cause the great flood. The order of nature and sequence of Mississippi floods is reversed. Natural floods begin above, in great tributaries, and travel in regular stages down the river. This extreme high water at New Orleans is an artificial condition, and is not due to a rise coming down the river from above. This condition of extreme high water is not temporary. It will be repeated at every rise of the river. It was repeated in the rise of 1893.

It is to be recalled that the Ohio River at Cincinnati, during the entire season of 1892, was remarkably low, with but one exception, which occurred on the 25th of April, when the water rose to the very moderate stage of twenty-seven and five-tenths feet below the flood mark of 1884, and then rapidly declined in five days to a stage forty-four and nine-tenths feet below the mark of that year. At this date in 1892 the Mississippi, at New Orleans, was full to overflowing. The volume of the river rose above the high mark of 1884, and stood above that mark for fifty-nine days.

Under such conditions, what will occur in the Mississippi Valley when the Ohio rises in flood as in 1884? The answer will come from considerate men—a calamity to startle the country.

Referring to the question of dams in the mouths of the Mississippi, the fact can be established by an analysis of the jetties—their character, extent, and office. But other concise proof is at hand. The testimony of the constructor of the jetties is conclusive. Hear him:

"The Mississippi River, at the Head of the Passes, where it has a width of 9,000 feet, is brought under complete control by our works. These sills diminish the entrance into the two great passes about 7,000 square feet each. Our works have, necessarily, disturbed the regimen governing the outflow to the sea of an enormous volume of water." (J. B. Eads, Report July, 1877.)

"The works that I built at the Head of the Passes for the purpose of deepening the shoal at the entrance to the South Pass were of such a character as to form an obstruction to the flow of the water." (J. B. Eads, Report H. R. No. 1,985, 1883.)

"If you will look on the chart, you will see a dam that I made at this point, and above that another, and still another dam above that, the effect of which was to throw that bar away up here.

"I built across the large pass a submerged dam connecting the head of the work with the shore; and another *here* to prevent any further enlargement of the two large passes.

"I erected dams across the head of the passes to the east of the entrance to the South Pass. Some of these were about 1,900 feet long. Here at the head of the passes show two dams, which we had laid across the entire river, with the exception of 800 feet entrance to the South Pass. This dam is over 9,000 feet in length. I had to build on the top of some of these. I had to raise the sill five feet higher. I had to cover a part of the bottom here, over which the water flowed, with a dam, which brought it above the water." (J. B. Eads, Report H. R., No. 848 et 56.)

There need be no longer any doubt concerning the existence of dams in the mouths of the Mississippi. The words of the constructor, "I had to," imply afterthought and makeshift. The original intention and authority was to jetty the South Pass. Much of the work that was done has direct relation to the other passes and completely controls them. Work on the jetties of the South Pass was first begun, when unexpectedly the water turned and ran off by the other passes; thus showing conclusively that even the initial work proved to be an active dam.

Already the Mississippi shows a disposition to escape from these obstructions, by cutting a new channel at Pass à l'Outre near the end of the present dam. This

erosion has proceeded to such an extent that alarm was manifested lest the river make for itself a new channel for discharge of its flood volume. Should this occur, it would at once cork the South Pass to navigation. A company has petitioned congress for authority and appropriations to jetty the Southwest Pass. To carry out the scheme would require that the present system of dams be re-enforced or raised in height. To give navigable water over the present formidable sill now at the head of this pass, a pronounced system of jetties would be required in Southwest Pass. Were the sill removed, its equivalent obstruction would become necessary in the other passes. The effect would be to dam still more the Mississippi and raise its flood waters to a height above restraint or control. Moreover, a rapid shoaling would take place; and the South Pass would presently be closed to navigation.

The danger is not alone from the abnormal high waters; but also from excessive cavings of banks, which follow all abnormal high waters. The government has failed to take cognizance of the changed conditions in the Mississippi caused by the jetty system. There will be this year more caving of banks and falling in of levees than ever before known. Abnormal high waters and excessive cavings are inseparable. These are now established in the Mississippi; and both will increase in degree year by year, so long as the condition of obstruction exists The Mississippi has the power to escape from or overcome obstructions, flowing as it does in an alluvial bed. In these conditions is found peril of incalculable magnitude to Louisiana and the Mississippi Valley.

II.

The contraction system has been applied to the Mississippi River below Cairo as rapidly as Congress would furnish appropriations. Various devices are employed, among which are levees. The plane of highest velocity is near the surface of the water in the Mississippi. This plane ascends with every rise of the river and maintains in flood a close relation to the surface of the water. Hence, levees are an essential part of any jetty or contraction scheme. The system has been in progress upward of twelve years and has now passed the limit of an experimental stage.

In a properly improved as in the natural Mississippi River, a flood wave should travel down the river in regular stages as it enters the river. A low stage behind the flood wave will follow down in natural and regular succession. Each rise in 1893 entered the Mississippi at Cairo with low stage in rear; but the low stage in its advance grew rapidly less and soon disappeared. When a well pronounced low stage in its progress down the Mississippi River runs out or is lost in the flood wave in its front, the evidence is complete that the flood wave is obstructed in flow. The succession of high and low stage that occurs at Cairo must appear and will be clearly defined throughout the length of an improved Mississippi River; otherwise the flow is shown to be obstructed. It shall now be proved, from the conduct of the Mississippi, that the contraction works establish a continuous dam in which floods are held back. When this shall be proved to have occurred in any one reach of the Mississippi—as for instance from New Orleans to Vicksburg—the whole system of contraction must fall into condemnation.

In the month of February, 1893, a moderate rise came out of the Ohio and entered the Mississippi, with its crest at Cairo, on February 28. The river was stationary two days. This was followed by a sharp fall of sixteen and three-tenths feet in nine days on March 10. This fall at Cairo was followed at Memphis by a fall during ten days of only nine feet on March 13; the river was stationary two days: at Helena, by a fall during eight days of only seven feet; at Vicksburg, by only a slight decline of four-tenths of a foot on March 18. The time of water travel from Cairo to Vicksburg is eight days. At this date the Mississippi from Vicksburg to New Orleans was far above danger point; at all other stations it was much below. The Arkansas River was low, and had been low for a long time. The Mississippi from Vicksburg to New Orleans remained above danger point the entire month of March. Here is unmistakable evidence that the low stage was lost; that the waters of the Mississippi were held back, and that the effect extended from New Orleans to Vicksburg, and even in some considerable degree to Helena and Memphis.

Had the Mississippi been unobstructed and free to discharge its volume, or had an improved condition existed in the Mississippi, the rise that came out of the Ohio in February would have traveled down the river in regular stages, and the large fall at Cairo would also have been correspondingly pronounced throughout the Mississippi to New Orleans.

The New Orleans *Picayune* of March 12, 1893, in an editorial, said:

"The present rise will run out to sea before any considerable re-enforcement can join it from other sources. The Missouri and the upper Mississippi are both frozen. There is no serious stage of water in the Arkansas and Red rivers, and nothing threatens from the Ohio and Tennessee valleys."

But the rise did not run out until long afterward. The high and dangerous stage remained in the Mississippi the entire month of March. There was no re-enforcement from above. In the natural order that water travels under normal conditions, the low stage that was present at Cairo on March 10 should have reached New Orleans on March 22; but the Mississippi at New Orleans rose and its high crest was maintained through the month of March.

Where shall a great flood now go, should one appear in the Ohio or any great tributary, under such conditions of damming? There is no space for it in the Mississippi River. The Mississippi is improved into a narrow longitudinal dam and is full of water. Will any sane person propose that one great flood shall climb upon another that is abnormal, and that both be impounded between high earth banks or levees?

On May 26, 1893, a fall occurred at Cairo of fifteen feet, which was followed at Memphis four days after by a fall of four and two-tenths feet, where the river remained stationary two days. It is found that the Mississippi at Helena declined only two feet and at Vicksburg only one and nine-tenths feet, within the time of low stage travel. At Helena, Vicksburg and New Orleans, excessive high stage continued for a long time afterward. The fall was large at Cairo, yet it will be observed that the refluence has steadily advanced up the Mississippi, with decided increase at Memphis.

Some unskilled one may say it was "the escaped water into the St. Francis basin that held up the Mississippi at Helena." Fortunately the basin acted as a reservoir. The opinions of many favor reservoirs to hold floods temporarily. Had the waters that were in the St. Francis on May 26 been retained in the Mississippi by levees, no fall could have been possible at Cairo. The damming did not begin in the St. Francis basin. It began in the Mississippi before any waters ran out of the basin, or before floods had entered that basin; for on March 2, 1893, the Mississippi at New Orleans rose to danger point. Deducting twelve days, the time of a rise to travel from Cairo to New Orleans, it is found that on February 18 the stage at Cairo was three and seven-tenths feet below danger point, while the mean stage for the eighteen days of the month was eighteen feet below danger point. These stages represent the only waters from Cairo that could have reached New Orleans on March 2, 1893. It is here shown that damming to dangerous flood height began nearly seven hundred miles below Helena.

On June 6, 1893, the Mississippi at Cairo rose to a point eight and one-tenth feet below flood mark of 1884. The Ohio at Cincinnati rose only to a stage thirty-two and five-tenths feet below the mark of 1884. The Upper Mississippi, Missouri, Tennessee and Arkansas rivers were low. The relativity of stages is unprecedented and conclusive. At New Orleans the stage was higher than ever before known. The exceptionally high stage at Cairo, while the Ohio and other tributaries are low, is precise proof that the Mississippi is now dammed from the passes to Cairo, a river distance of nearly eleven hundred miles.

The Mississippi is deteriorating in channel capacity to discharge flood volumes. This deterioration is now rapidly increasing. The detention to floods in their travel down the river creates the precise condition in which deposition of sediment takes place. The current along the bed of the river is in consequence reduced to a minimum. The mass of sediment always near the bottom is arrested in its forward movement and is thrown upon the bed of the river. It reduces the sectional area of discharge, and remains there to vex the Mississippi. The contraction system antagonizes the Mississippi in its natural effort to carry onward to the gulf an enormous volume of sediment and of flood.

WILLIAM L. ELSEFFER, C.E.

18 Broadway, New York City, November, 1893.

THE GERMAN STATE INSTITUTE FOR PHYSICAL TECHNOLOGY.*

By FRANZ BENDT.

TOWARD the end of the seventies, electro-technology had made such rapid advances that it became absolutely necessary to come to some international agreement respecting units of measurements as they occur in that science. For this purpose, the French government in 1881 and 1884 invited the most eminent men in the physical and technical world to Paris, where the Electrical Congress determined these units.

But to be able to carry out experimental research necessary for the determination of such units, it was essential to obtain a well-trained staff of experimenters and large and convenient premises. The physical and technical laboratories of the German universities were already devoted to teaching purposes entirely, and, therefore, it was impossible to carry on the necessary research work in these places. Germany had, in fact, no institution specially devoted to the kind of measurements necessary for the determination of such units as referred to above.

It had often been pointed out that a special institution would be of great value for research work, such as physical technology requires at the present time, if properly carried out by qualified men. The means, however, were not forthcoming until Werner von Siemens presented to the nation a large plot of land at Charlottenburg for the purpose. The State accepted his gift, and the Reichstag found the necessary money. Even before the buildings were completed, the institute began its work on hired premises in October, 1887, under the direction of Professor Helmholtz.

The institute is divided into two departments: the first for purely scientific research, *i. e.*, for the determination of physical constants and for devising the most accurate methods of measurement; the second department for technical research as applied to practice. At the beginning of 1891 the buildings of the first department were finished and immediately occupied; those of the second department are still in the builders' hands, work being meanwhile carried on in the Charlottenburg Polytechnicum. Besides a president and a director of the second department in this state institute, there are eight active members, nine assistants, seven scientific and four technical instrument makers, besides a number of first-class skilled mechanics and laborers. In the five years since its foundation a large amount of fresh experience in new methods has been gained.

As mentioned above, it has been principally electro-technology which has required a number of very delicate measurements, and these were made at the new institute. For example, accurate measurements are wanted to estimate the amount of light necessary for the lighting of a certain space, and to know whether the brilliancy of the lamps corresponds to this amount of light. As to such measurements, the Paris Electric Congress of 1884 had come to an understanding, and they are now carried out by the most accurate methods in this German state institute. Standards of electromotive force, current intensity and resistance of various metals are made to the requirements of practice. The so-called absolute unit of light, as that proposed by Violle, at Paris, is a very complex quantity. This unit was to be the quantity of light emitted by the surface of one square centimeter of molten platinum at the moment of solidification. It has so far been impossible to determine this quantity directly; but by indirect methods very near values have been obtained. While it was the object of the first department of the institute to realize a standard unit of light corresponding to the highest claims of science, the second department has had to make this unit as simple as possible for use in practice.

Hitherto the measure of light has been the candle power, but there has been a German and an English candle power. Lately, however, a new lamp has been devised by Hefner von Alteneck as a standard of illumination; this has done away with all confusion. The "Hefner" light is now universally recognized in Germany as the standard measure of light. The lamp is fed with acetic acid ether ($C_5 H_{11} C_2 H_3 O_2$), and has a flame 40 millimeters in height. This standard has been compared with Violle's unit, and with the old candle power, and the relative values have been determined with the greatest exactitude—this in the second department of the institute.

Other researches of great importance made at the state institute have been heat measurements. It is well known that the accuracy of the average thermometer cannot be relied on. Not only physicists and engineers, but also physicians, have always wanted precise and tested thermometers, so the institute took upon itself to supply this want. First of all, a better kind of glass had to be produced, having great toughness. This was obtained in 1884 at the laboratory for glass industry at Jena, and it remains almost unimpaired at high temperatures. The next step was to compare various thermometers and their scales with one another and with the air thermometer, which is the most accurate of all thermometers, because air expands more uniformly with increasing temperature than any other body. This work of comparison has been carried out to very high degrees of heat, such as are generally only measured by the electric pyrometer. When we remember that the melting point of the precious metals, such as silver, platinum, gold, and copper, lies above 1,000 deg. Cent. (say 1,800 deg. F.), we can imagine the scientific and technical importance of thesenew determinations where there is a possible error of not more than 5 deg.

The demand of engineers and physicians for officially tested thermometers has been so great that the state institute could not cope with it. Therefore in 1889 a special laboratory was built at Ilmenau by the government of the Grand Duchy of Weimar. It works on the same lines as the state institute, and is controlled by the latter. In Ilmenau 70,000 thermometers have been calibrated, while the state institute has examined 10,000 clinical thermometers. The exports to foreign countries have also increased considerably, so that now the certificates for these thermometers are printed in French, English, Spanish and Portuguese. The thermometer, as used by a physician, has a relatively small range: engineers, on the other hand, need instruments to measure both very high and very low temperatures.

These latter are calibrated by the state institute, and about 4,000 have been examined. Instruments made of the new Jena glass could at first only be made to read up to about 360 deg. Cent. (680 deg. Fahr.) More recently, however, by filling the space in the thermometer above the column of mercury with nitrogen, 460 deg. Cent. (860 deg. Fahr.) have been read off; and lately the Jena laboratory for glass industry has produced a new glass of great resistance, so that a glass thermometer has been made to read 550 deg. Cent. (1,020 deg. Fahr.) In this instrument the hollow of the thermometer is filled with compressed carbonic acid gas.

Spirit thermometers for low temperatures have also been tested and calibrated to —80 deg. Cent. (—112 deg. Fahr.) All these thermometers have been of extreme value, especially to those engaged in the chemical and allied industries. The state institute devotes a great deal of interest to these researches, and is continually devising new and better methods and apparatus. At the present moment a room is being specially built, in which the temperature shall always be constant.

Another kind of work of the institute is that devoted to acoustics. It is necessary that musicians should have accurate tuning forks; and at an international conference at Vienna in 1885 it was determined to decide on a standard tuning fork giving 435 vibrations a second for the note A.

A standard of this kind has been constructed at the state institute, with such precision that the number of vibrations came to within 1-50,000 of the specified number. By means of very delicate methods, which cannot here be described, this standard has been frequently checked, and some 1,900 tuning forks have been tested and corrected.

A further important task the institute has set itself is the preparation of uniform measures for fitters and other mechanics, and to simplify scientific instrument making. Thus the late director of the second department of the institute, Dr. Lowenherz, succeeded in establishing a uniform screw thread for the German empire. Anybody can understand that where hitherto a variety of screw threads had been in use, it became practically impossible for delicate instruments, made, say, in one state, to be repaired in another state having another standard thread.

In many other ways this deservedly admired institute has been useful. It has tested "spirit" levels, such as are used with scientific instruments, for the purpose of adjusting them horizontally. For it has been found that impurities, such as water, contained in the liquid ether in these levels, cause chemical action on the glass, thereby preventing free play in the levels. However, the new Jena glass as used in thermometers has proved better also for levels, and with the use of these more accurate levels important discoveries have been made.

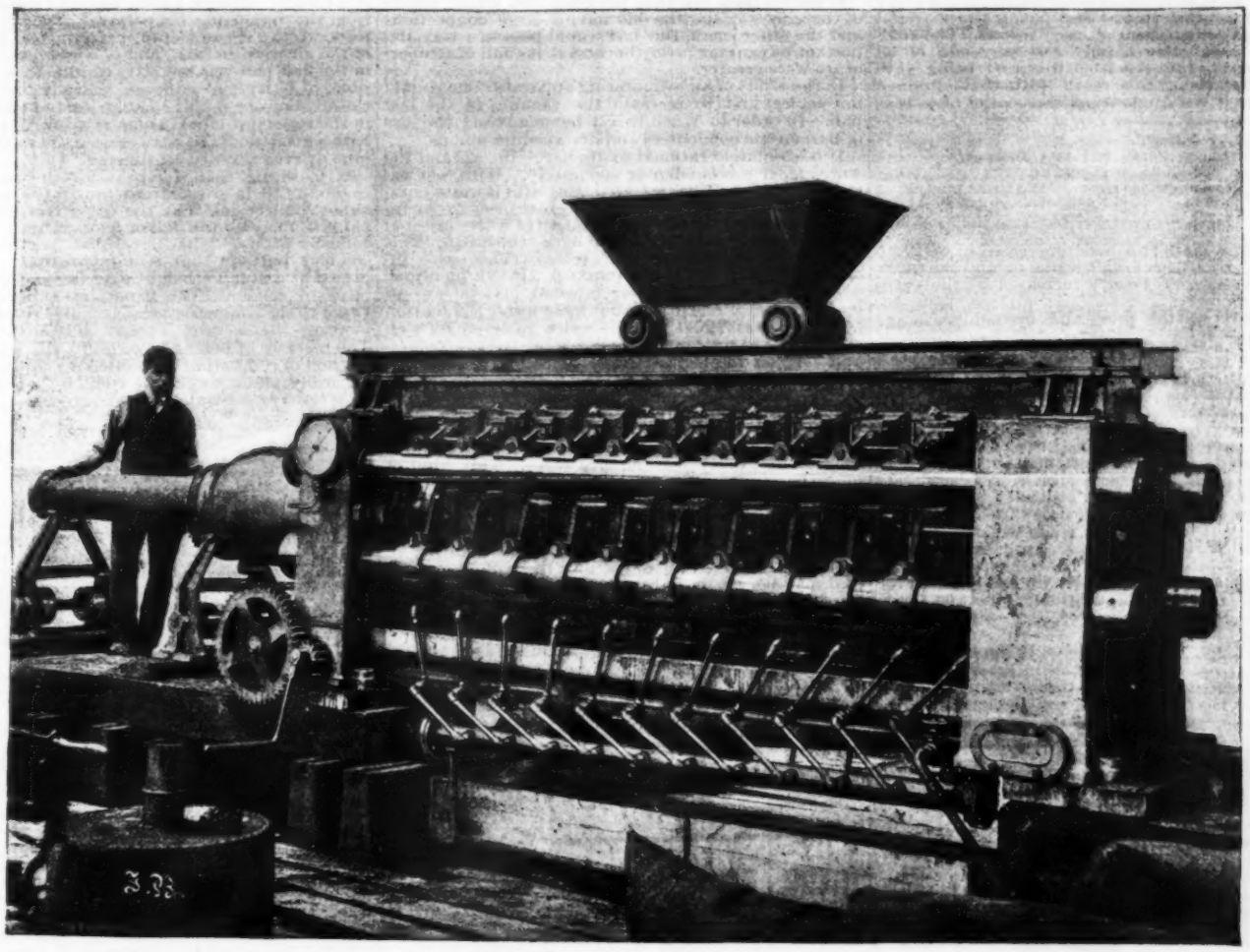
Experiments have also been made with smokeless powder and other modern inventions.

Lastly, the institute has had to deal with legal questions. In all branches of physical and chemical industry, a large amount of capital has been invested, and all kinds of disputes between producer and consumer are daily dealt with before the judges. It is, therefore, necessary to establish scientific principles which should help the judge to correctly interpret the law. A case in point is furnished by a bill introduced into the Reichstag by the Postmaster-General, which contained clauses dealing with the protection of telegraph and telephone wires from the effect of heavy currents in electric lighting mains. There was a good

* Translated from *Die Nation*.—*Engineering*.

deal of lively discussion and contrary opinion among electrical engineers, while the law must, of course, be supported by the overwhelming testimony of experts. In future the highest tribunal for this kind of expert evidence will be the state institute, which will collect the views necessary to submit to a judge for the administration of justice.

It is pleasant to note that many results of the work of this institute for physical technology have been increasingly accepted in international intercourse.



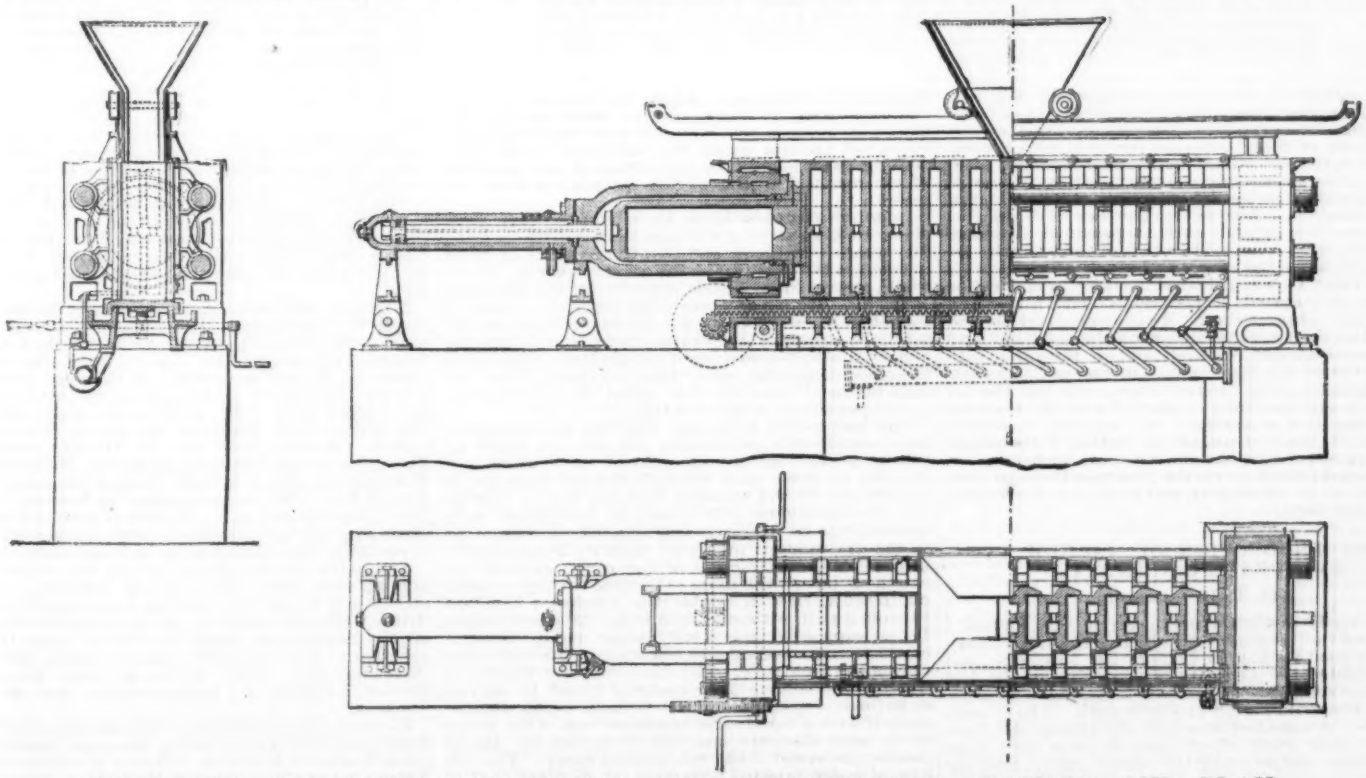
MITCHELL'S OIL PRESS.

For this purpose, only last year (1892) the president of the institute and two assistants attended the meetings of the British Association held in Edinburgh, where many of the German proposals were agreed to.

IMPROVED OIL PRESS.

THE oil press illustrated, and which, says the *Engineer*, we have seen at work pressing oil from castor seed, is of a new design lately completed at the works of Messrs. Easton & Anderson, Erith. Those familiar with the working of oil presses will note the marked improvement in construction by having the press lying in a horizontal position, and the material to be pressed fed from a traveling hopper direct into the press boxes, and retained there while being pressed by means of a removable plate between the press boxes and the sole plate. There are ten press boxes with faces 2 ft. 10 in. by 11 in., taking an average of 2 cwt. of seed at each charge, and the pressure is obtained by a 16 in. ram and cylinder, having an auxiliary tail cylinder and ram to withdraw the main ram and boxes after the pressing is completed. The novel feature in the tail cylinder is that it does not detract from the gross pressure on the main ram, but augments it by means of having the piston rod hollow, giving a free communication between the main cylinder and the corresponding front end of the auxiliary piston, the forward pressure being the area of the main ram plus the area of the small piston minus the area of the rod, and the drawback pressure is obviously the area of the small piston minus the area of the rod. But when working as with high and low pressure accumulators, an adaptation of the auxiliary cylinder obviates the necessity of having a low pressure accumulator by allowing the high pressure first to act on the small ram and finish with pressure on the large one, thus accomplishing the same work with one accumulator instead of two, and one set of pumps and piping. The working pressure being two tons per square inch, the gross forward pressure on the cake is 422 tons.

The mode of working the press is exceedingly simple, and almost entirely mechanical. The press boxes being open, the hopper is drawn along the top of the press, and as the aperture at the bottom passes over the several openings, the material falls through and fills the boxes; pressure is then applied, and the oil is expressed, falling on to the removable plate and into the drains provided for its reception along each side of the press. When the pressing is completed, the ram and boxes are withdrawn, also the removable plate, and the "cake" falls through corresponding apertures in the sole plate. The removable plate is replaced and the operation repeated, taking from



MITCHELL'S OIL PRESS—TRANSVERSE AND LONGITUDINAL SECTIONS AND PLAN.

seven to twelve minutes for each charge. The press boxes are hollow, and have knuckle jointed steam connections, allowing any required temperature to be maintained for "hot pressing," and when arranged for pressing paraffin scale, or such like material, necessitating a very low temperature, it can be equally easily obtained by circulating cold brine through the boxes. By a simple process of galvanizing or tinning the faces of the boxes, the expensive item of press cloths is obviated, so that the manipulation and loading of the press is almost purely mechanical.

The press we illustrate has been tested for efficiency in the Erith works—castor seed being the material used—and yielded most satisfactory results. The analysis of the "cake" showed only 5·09 per cent. of oil left in it, the oil expressed from the seed being 41·93 per cent. Comparing this result with that obtained by analysis from the Anglo-American type of press is as follows:

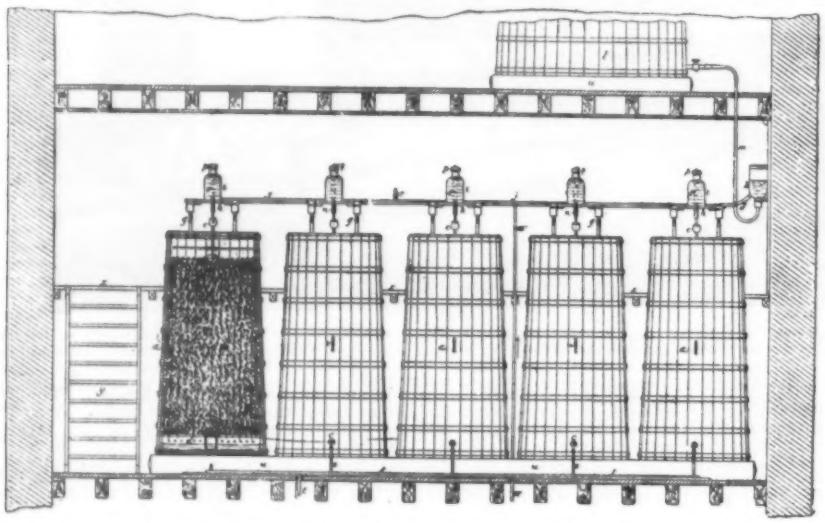
Analysis of cake by Mitchell's system of pressing.		Analysis of cake by the Anglo-American system.	
Moisture.....	6·30 per cent.	Moisture.....	11·86 per cent.
Oil.....	5·09 "	Oil.....	7·72 "
Marc.....	88·61 "	Marc.....	80·42 "
	100·00		100·00

The cake as a manure is much increased in value by the smaller percentage of oil it contains, and the profit on working the seed is greatly increased by the extra yield of oil.

The inventor of the press and system is George Mitchell, London.

AN AUTOMATIC PROCESS FOR THE MANUFACTURE OF VINEGAR.

IN this process by E. Barbe, for the manufacture of vinegar, all manual labor is dispensed with, and the alcoholic liquids are delivered into the generators continuously. The generators, which are placed side by side in rows, are 2·25 m. high, and their width is 1·15 m. at the bottom and 0·85 m. at the top. Their capacity is about 15 hectoliters, and they are charged each with 200 kilos. of oak shavings of spiral form, presenting a total surface of about 34 square meters. At the lower part of the generator the air required for the acetification is introduced through fine apertures,



BARBE'S PROCESS OF MANUFACTURING VINEGAR.

a, generators filled with oak shavings; *b*, spiral shavings of oak in *a*; *c*, air valves of the generators; *d*, perforated boxes (see lower part of *a*) for distributing the air evenly in the generator; *e*, *f*, arrangement for distributing the alcohol evenly in the generator; *h*, bottle shelf; *i*, distributing bottles; *j*, pipes from ball-tap reservoir to bottles; *k*, ball-tap reservoir; *l*, main alcohol reservoir; *m*, pipe to ball-tap reservoir; *n*, pipes conducting alcohol into bottles; *o*, siphons; *p*, india-rubber stoppers; *q*, air pipes; *r*, air valve; *s*, *e*, pipe from the hydrostatic balance, connected with *g*; *s*, discharge pipes for vinegar; *t*, pipes carrying vinegar into storage cellar; *u*, supports for generators; *v*, thermometer indicating the temperature in the generator; *x*, stage; *y*, steps to stage.

a great number of which are contained in each box, the front of which has a single hole only. These boxes are arranged crosswise in each generator. The apertures in the front of these boxes are provided with concentric valves, through which the necessary amount of air passing into the generator is regulated according to the temperature inside the apparatus and the progress of acetification. Above the generators, bottles of about one liter capacity each are provided, all standing on the same level. The necks of these bottles are connected with one common branch of air pipe, a special valve in which leaves it either in connection with the atmosphere or connects it with a reservoir containing compressed air. Two openings on the bottom of the bottles connect them on the one hand with the general alcohol reservoir, and on the other with the interior of the generators. By means of a hydrostatic balance, about every fifteen minutes the air branch is automatically connected with the reservoir containing the compressed air, whereby a certain quantity of the contents of the bottles is discharged into the generator by the aid of a rotating distributor. The vinegar formed leaves the generator through pipes provided at its lowest part, and then runs into barrels to cool and clarify.

THE PRODUCTION OF VACUUM IN EVAPORATING APPARATUS.*

By T. H. CAMBIER.

IN a study published previously in this journal I developed the principles on which rests the production of a good vacuum in evaporating apparatus, and demonstrated the necessity of producing in the last pan of the evaporating apparatus a maximum vacuum, which only could permit excellent work. I have seen a number of manufacturers radically change the character of their triple effects, furnish them with large connections and adopting the means above, assuring themselves of the discharge of the condensing water, and forgetting one thing, the most necessary of all—to promote the fall of the temperature. All efforts fail before the forgetfulness of this chief principle of a large evaporation from a given surface. It is very good to assure the free passage of the vapor formed by large connections, but still it is necessary to adopt means to produce this vapor. Now its formation is not directly dependent on the cross section of the connections; it is created, all other conditions being equal, by the fall of temperature.

It results from this that between two triple effects of the same surface, the one having large connections and the other small, the last would possess a very important advantage over the first if its fall of temperature were greater.

In the study of an evaporating apparatus one should not neglect first to increase the vacuum in the last pan. In order to reach this, I have advised the use of barometric condensers and dry vacuum pumps.

It is absolutely rational to discharge the air and the water from the condenser separately. With wet vacuum pumps, as I have stated, this still is quite paradoxical and can be modified in a great measure by increasing or diminishing the quantity of water injected without modifying the vacuum in the third pan. This anomaly is, however, easy to explain. The space induced by the piston of the pump is always identical, while the quantity of water injected may be less or more. Then, if one injects but little water the tension of the vapors is great, but the space reserved by each stroke of the piston for the air is relatively considerable. If, on the contrary, one increases the volume of water, the quantity of air which disengages also increases, but the space reserved for the removal of this air diminishes, since the water takes its place.

It is this that permits us to say that with a wet vacuum pump, when one increases the injection water the vacuum decreases, and *vice versa*. This kind of pump has a critical point as to the proportion of water passed through it relative to the total volume to be passed through. It is not the same for dry pumps. When in the dry vacuum condenser there is an increased supply of condensing water, the quantity of air to be extracted increases, but the volume of air that may be removed by the dry pump is not diminished by the fact that a larger quantity of water passes through the condenser. Again, the volume handled by a dry pump by every quart of water sent to the condenser being in general much more important than in the wet vacuum pump, the variations in the condensing water modify the proportion of the quantity of air removed to that of the quantity of water injected.

In order to fix these ideas, let us suppose that for a given work we have a wet vacuum pump discharging fifty quarts per second, and that the quantity of water injected in the same time was twenty quarts. There would remain thirty quarts capacity for the discharge of the air. If we reason carefully from one cause to the other, to carry twenty-five quarts of injection water the quantity of air will augment, and in order to remove this increased quantity of air, there will remain to us less disposable space than previously, since we shall not have more for this object than twenty-five quarts per second in place of thirty.

The barometric condenser and the vacuum pump have considerable advantages, for one can stand on this principle, that the quantity of water which it is possible to make pass through the said condenser is limited only by the quantity that one has to dispose of. The barometric tube could be established sufficiently large to discharge any quantity of water. As to the dry vacuum pump, its capacity being entirely utilized in the extraction of the air, it acquires an enormous power, the more so because the dry vacuum pump can work with double the quickness of a wet vacuum pump, without diminishing its effectiveness. Let us suppose at once a wet vacuum pump discharging 50 liters per second and receiving 25 liters of water during the same time. The relation of the volume of water to the volume of air removed would be as one is to one. Suppress the wet vacuum pump and replace it with a barometric condenser and a dry pump of the same diameter, and then let us turn the last at double the speed of the wet vacuum pump. The volume of water injected remaining at 25 liters, that of the air removed would be $50 \times 2 = 100$ liters, and the tension of the air would be but one-fourth that of the wet vacuum pump.

As proof of this, the low vacuum observed in the majority of evaporating apparatus comes often from the tension of the air in the condenser. I can cite a number of cases where the water emerges from the air pump at a temperature which would correspond with a vacuum of seventy centimeters, while the real vacuum would scarcely reach sixty to sixty-two centimeters. This difference proves only the insufficient arrangement for removing the air. I could cite a strange case of a factory in which I have seen the water discharged from the pump at a temperature of 40° C., which corresponds to a vacuum of 70·51 centimeters, if the tension of the air were normal, and of which the real vacuum in the first pan was but sixty centimeters. It is impossible, it is true, to suppress entirely the presence of the air, but one might combat it more effectively than in the cases just cited, where it would have been easy, with a good pump, to have carried the vacuum to sixty-nine or even seventy centimeters.

It is wrong, then, I repeat, for the manufacturers to modify their evaporating apparatus in respect to vapor connections, if at the same time they take no pains to increase the fall of temperature. Barometric condensers on ordinary apparatus have very large secondary purpose, but still interesting. As they are placed at a notable height over the pan of which they have to condense the vapor, the pipes carrying the vapor to the condenser form veritable overflows, which increase the security against entrainment of sirup. The increase of height is certainly the most effective method of combating entrainment. Gravity thus acts naturally, and without it it would be necessary to place apparatus or catchalls for the purpose.

* Translated for the *Louisiana Planter* from *La Sucrerie Indigene*.

GETTING AND DISTRIBUTING THE NEWS OF THE WORLD.

EARLY one morning, not long ago, a party of Mohammedans desecrated, in some fashion, a place of worship in Calcutta. A fight followed and the Brahmin defenders of the temple killed six of the Mohammedans. This piece of news reached the offices of all the newspapers in Calcutta long before noon. At 10 o'clock a young man ran into the telegraph station of the government lines.

"United Press, London," he hastily wrote, "Mohammedans desecrated Brahmin temple here 7 morning. Fight followed. Six Mohammedans killed. All quiet now. May lead serious complications."

This brief despatch was telegraphed to the office of the Eastern Telegraph Company in Bombay, whence it was transmitted to Aden. In Aden it was received in the office of the Hindoo-European Cable Company. The operator sent the message into the cable room, and in a few minutes later it was on its way to Suez. There it was delivered to the Eastern Cable Company, whose operator immediately sent it to Malta. At this place another operator of the same company repeated the message to Lisbon. From there it had only a short stretch of sea to cover to reach Penzance, where, unmolested by pirates or aught else, it was telegraphed to its destination in London.

Now, from the moment that the operator in Calcutta touched the key of his clicker until the message was delivered to the man who was on duty in the United Press office in London, two hours had elapsed. But, owing to the kindly habits of the sun, although the message had been filed in Calcutta at 10 A. M. it was received in London at about 7 A. M. of the same day.

The United Press man made two copies of this message. One he sent without delay to the Central News, of London. The other he sent by cable to the United Press office in New York. The man in the Central News office at once telegraphed it to the offices of all the afternoon and evening papers in England and Scotland. The man in the United Press office in New York received the message shortly after 2 A. M. of that same day. That roisterer, the sun, was still turning night into day on the other side of the Atlantic.

Now, at 2 A. M. most of the newspapers in New York have already gone to press, but it often happens that they issue a second edition even at a later hour to publish important news. At any rate, when the man in the United Press office receives that message at 2 A. M. he almost becomes excited.

"Here!" he cries, "Grab a manifold book! Take this."

Some man in the office seizes a book of tissue paper interspersed with sheets of carbon paper, inserts it in a typewriter and writes—each impress of the key recording itself upon thirty sheets—this message:

"CALCUTTA, July 6.—A number of Mohammedans desecrated a Brahmin temple in this city at 7 o'clock this morning. A fight ensued and six of the Mohammedans were killed. All is quiet now, but it is possible that serious complications may arise from the affair."

A minute later messenger boys set out for the offices of all the newspapers that receive this service and hand in the despatch. At the same time half a dozen telegraph operators in the United Press office receive copies of it, and as quickly as they can they send it over their wires. One operator's wire runs to the United Press office in Chicago, where the message arrives—still, thanks to the sun—a little after 1 o'clock. Another wire runs to Albany, another to Philadelphia and Pittsburg, another to Baltimore and Washington, and so on until the night manager of the United Press office in each of the big Eastern cities in the United States has it. In each of these offices it is again received upon manifold sheets, again distributed to operators and again sent on to many more cities.

And so the message flashes across the country, zigzagging everywhere, like a bolt of lightning, so that no city may be omitted, gaining hour after hour as it strikes westward, until even before midnight it reaches all the newspapers along the Pacific slope that are members of this globe-encircling institution, informing them that at 7 o'clock of the day that has not yet dawned for them six Mohammedans were killed in Calcutta.

There are nearly 2,000 daily newspapers in the United States, and nearly all of these—the paper published at a county seat in Maine, as well as in a farming town in Kansas, no less than those in the leading cities of the country—publish daily authentic news dispatches of

the most important events occurring in all quarters of the world. The above account, from a description in the New York *Sun*, shows how the marvelous work is done by the United Press Association, so that the news received by each newspaper costs the paper itself comparatively little, as each paper also sends to the association news of importance occurring in its own neighborhood.

ATOMS AND SUNBEAMS.

By Sir ROBERT BALL, F.R.S.

How is the sun enabled to maintain its tremendous expenditure of light and heat without giving any signs of approaching exhaustion? The atomic theory of the constitution of matter exhibits the mechanism of the process by which that capacity of the great luminary for supplying the radiation so vital to the welfare of mankind is sustained from age to age.

The remarkable doctrine first propounded by Helmholtz removed all real doubt from the matter. What he did was to refer to the obvious fact that the expenditure of heat by radiation must necessarily lead to shrinkage of the solar volume. This shrinkage has the effect of abstracting from a store of potential energy in the sun, and transforming what it takes into the active form of heat. The transformation advances *pari passu* with the radiation, so that the loss of heat arising from the radiation is restored by the newly-produced heat derived from the latent reservoir. When this universally accepted doctrine is tested by arithmetical calculation, it is not found wanting.

This argument, however, does not offer any very clear conception, or indeed any conception at all, of the precise *modus operandi* by which, as the active potential energy vanishes, its equivalent in available heat appears. I have always felt that this was the unsatisfactory part of an otherwise perfect theory. It was, therefore, with much interest that I became acquainted, a short time ago, with a development of the molecular theory of gases which afforded precisely what seemed wanted to make every link in the chain of the great argument distinctly perceptible.

First, let it be noted that, though matter is capable of subdivision to a certain extent, yet there is a limit beyond which subdivision could not be carried. It is certain that the diamond can be divided to such an extent that each individual particle can be perceived only by the keenest power of the most powerful microscope. We know, however, that this subdivision cannot go on indefinitely. It is indisputable that there is an atom of diamond so small that it must refuse to undergo any further division. Thus, we are aware that every body is composed of a multitude of extremely, but not infinitely, small molecules.

The next point relates to the condition in which these molecules are found. At first it might be thought that, in a solid at all events, the little particles must be clustered together in a compact mass. The fact is far otherwise. Were the sensibility of our eyes so greatly increased as to make them a few million times more powerful than our present organs, then we would see that the diamond atoms are each in a condition of rapid movement of the most complex description; each molecule would be seen swinging to and fro with the utmost violence among the neighboring molecules.

The same thing occurs with a gas, only, in the case of the gas, the molecules have a vastly greater liberty of movement. The philosopher knows that oxygen, for instance, consists of myriads of molecules, identical in weight and in other features, and darting about one among the others with velocities which vary, perhaps, between those of express trains and those of rifle bullets.

It is known that the immediate effect of the application of heat is to increase the velocities with which the molecules move. If, therefore, a volume of gas be heated, the velocities with which its molecules are animated will be in general increased. The more rapidly moving molecules will strike each against the other with increased violence, and the contemplation of this single fact leads us closely to one of Nature's greatest secrets.

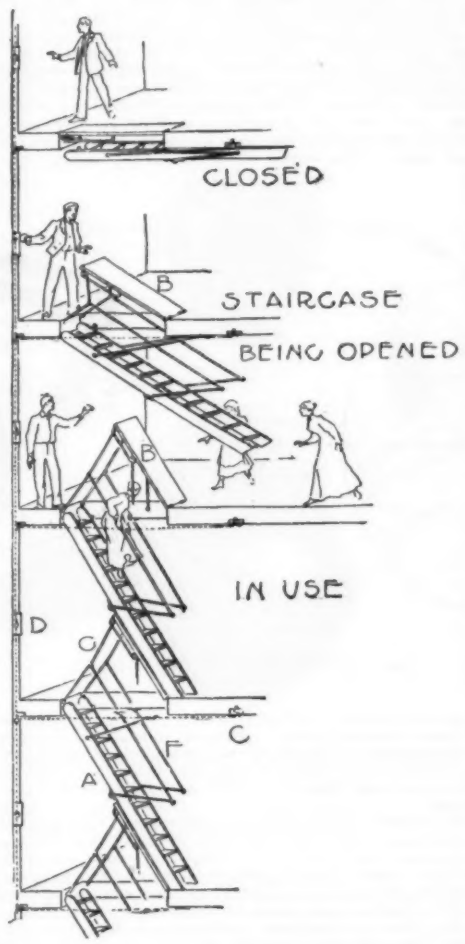
Let us think of the abounding heat which is dispensed to us from the sun. This heat comes, as we know, in the form of undulations imparted to the ether by the heated matter in the sun, and transmitted thence across space for the benefit of the earth and its inhabitants. We must observe, however, that there is another kind of molecular motion besides that which the molecule possesses as a whole. The molecule, itself, is by no means to be regarded as a simple rigid particle; if it were so, it is certain that we should receive no heat at all from the sun. We have the best reasons for believing that each molecule somewhat resembles an elastic structure made of parts which can quiver like springs, and so arranged as to be susceptible of many different modes of vibration. The extraordinary activity of the movements which take place within the molecules may be appreciated from a settled fact. We know that certain vibrations in the molecules of hydrogen take place with such extraordinary frequency that about four hundred and sixty millions of millions of them are performed in each second of time.

Provided with these conceptions, we can see without difficulty how the sun's heat is sustained. The immediate effect of the expenditure of heat or light by radiation is to diminish the internal energies of the molecules. These energies are restored by the transference of energy obtained from the general velocities of the molecules regarded as moving projectiles. It can be shown that at the sun, on account of its immense mass, three hundred thousand times greater than that of the earth, the actual intensity of gravitation at the solar surface is sufficient to tend to impart to all objects an increase of velocity toward the sun's center at the rate of four hundred and fifty-seven feet a second. The contraction of the sun, however, tends to an augmentation of the molecular velocities, and this augmentation just goes to supply the loss of velocities which is the consequence of the radiation.

Nothing, however, goes to show that the efficiency of the sun for radiating light and heat must always be preserved exactly at its present value. It is of the essence of the argument that the contraction of the solar volume is still in progress. The bankruptcy of the sun must arrive in due time, when, after certain millions of years, the sun has so far contracted that it ceases to be a gaseous mass. Once this state has been reached, a few thousand years more must witness the extinction of the sun altogether as a source of light, and the great orb, at present our splendid luminary, will then pass over into the ranks of the innumerable host of bodies which were once suns but now are suns no longer.—*Fortnightly Review.*

AN EMERGENCY STAIRCASE.

ONE difficulty in connection with the recent acts under which additional means of escape in case of fire have to be provided in all factories, asylums, theaters, hospitals and wherever large numbers of people live or are employed, is that staircases of the ordinary description occupy more space than is always available. The object of the emergency staircase, invented by Mr. S. T. Rawlings, of Frome, England, is to meet this difficulty and also to furnish a convenient extra exit from upper floors or galleries for all public or private buildings. It is claimed that it forms a complete and very substantial staircase, always ready for immediate use, and yet, when not in use, it takes up no available space. A series of light staircases are kept suspended under the ceilings below trap doors placed in the floors of upper rooms, and on a catch being pulled out they drop immediately and open the trap doors, which are so balanced as to allow the stairs to fall gently to the ground. Small cupboards in the wall of each room contain the handles D, which are connected with the wires, represented by dotted lines, for lowering the



staircases. In case of necessity the glass fronts of these cupboards should be broken, which causes a bell on each floor to ring, then on pulling the handle D, the catch C is released and the stairs A drop down simultaneously, opening at the same time the trap doors B in the various floors, the handrails F and guards G extending on either side of the stairs, the latter serving to prevent persons from falling into the opening. The stairs can be placed directly under one another in a continuous length at right angles to each other or in any other position that may be desirable. The apparatus can be made plain or ornamental in harmony with the rooms or corridors in which they may be placed, and is suitable for any buildings in which a number of persons are likely to be on upper floors at any one time. Among other advantages claimed for it are that it can be fixed without any structural alterations or interference with the present arrangements of furniture, fixtures or machinery; that when open it does not form a flue to attract fire or smoke; it is so constructed that it can be used by the infirm and the most timid without assistance, and besides being so nicely balanced that if it were opened while persons were standing beneath, it would not drop with sufficient force to hurt them; it is so guarded that even in the event of a panic it would be almost impossible for those descending it to fall. It has been fitted up in many factories, asylums and public buildings and is considered a practical and useful invention, easily worked, not liable to get out of order and affording a safe and speedy means of escape in cases of emergency. Any further particulars can be obtained from the patentee and sole maker, Mr. S. T. Rawlings, South Parade Works, Frome, England, where the staircase may be seen arranged for use.

GALLS AND THEIR OCCUPANTS.

By E. A. BUTLER.

THE aphides, or plant lice, from the very nature of their food, the juices of plants, which they obtain by puncturing the twigs or leaves, necessarily more or less modify plant growth and produce shrivelings and distortions of various kinds. Such a result may be expected to follow the attacks of all species, but some go further than this and produce actual galls, which, externally, closely resemble those caused by other kinds of insects. The natural history of this group is so peculiar that it will be necessary to sketch the plan of their development before the connection of the galls with the insects can be properly understood. There are many different kinds of aphides, and every one is probably familiar with their general appearance. The soft green bodies, commonly called "green fly," which cluster in sticky crowds round the softest and tenderest shoots of rose trees, and the black ones which crowd equally thickly round the tops of broad bean plants, are, perhaps, two of the most familiar examples. They form a well marked division of the order Homoptera, which are distinguished from other insects by having four wings of a more or less similar appearance, and a pointed beak containing four fine piercing needles, and by passing through an incomplete metamorphosis—that is, never becoming a limbless, resting chrysalis, but having legs and remaining more or less active all through their life.

Assuming, then, that we know what sort of insects we are speaking about, let us take, to illustrate the group, the species called *Schizoneura ulmi*, which makes galls on the leaves of elm trees. The eggs of this creature are exceedingly minute yellowish or brownish bodies, which are to be found, if diligently sought for at the approach of winter, in the crevices of the barks of trees which have borne the insect during the preceding summer. Each of these eggs represents the entire family of a single pair of insects. The mother was but little larger than the egg she produced, and she died immediately upon its laying. Sometimes, indeed, she dies before her solitary egg is laid, in which case the egg would be found in such situations as above described, but inclosed within the dried skin of its parent. Of course, one would naturally expect that when these eggs hatch they would give rise to insects similar to those which produced them, or, at least, to creatures which by a process of development and growth would gradually become like them. But when we are dealing with aphides, such ideas must be put aside altogether, for here we find developed to a wonderful extent the phenomenon called "alternation of generations," a phrase by which is meant that forms, more or less different from one another, regularly succeed one another in a cycle by some process of multiplication, so that a number of "generations," so to speak, intervene before we arrive again at the same sort of thing that we started with. In the present instance, no less than seven such generations constitute the cycle, and these must successively appear, each being the viviparous parent of the next in the scale, before we arrive again at the egg with which we commenced. Some of these seven are pretty much alike, but the rest differ greatly.

It is obvious that if we are to speak intelligently of these different stages in the life history of a single insect, we shall require distinctive names for the entire seven. No one of them, to the exclusion of the others, can be described as the insect itself; nothing short of the whole series can fairly be considered as representing this. Nor are they stages like the larva and pupa of other insects, the differences between which are no more than what are caused by a mere change of skin, so that the insect remains one indivisible creature throughout its life. On the contrary, in each one of these stages the insect may be represented by an indefinite number of separate and independent beings, which in fairness ought all to be taken into account in estimating the produce of a single egg, up to the time when the next egg appears. Of course, these stages might be distinguished numerically, but names descriptive of their functions are preferable. Such a system of names was devised by Lichtenstein. They were expressed in French, and no thoroughly satisfactory English equivalents seem to be available. Not to worry our readers, however, with these rather complicated foreign expressions, we will render into English the most characteristic portion of the names, and thus we speak of the creature which issues from the abovementioned egg as the "stem mother" or "foundress." Buckton, the historian of the British aphides, gives this stage the name of "queen aphis," in consequence of certain resemblances between her functions and those of queen bees or wasps. If this name be used, however, it must be borne in mind that while queen bees and wasps are fully developed females which mate with male partners and produce eggs in the usual way, nothing of this sort takes place in connection with the queen aphis. On the whole, it will probably be productive of less confusion to use the term "stem mother," implying by this that the form so designated is the first active six-legged member of the series, and that she is, as it were, the mother of the stock, the progenitor from whom the whole pedigree is derived.

The egg hatches in springtime, and the stem mother, who has no wings, and is, therefore, not likely to wander far, at once begins to attack the young leaves on the tree on which she was hatched, piercing them with the fine needles in her beak as soon as they unfold from the bud. The damage done to the tissues by the punctures induces an abnormal growth, and little cavities appear on the leaf, within one of which the stem mother nestles. The leaves that have been attacked in this way now curl downward and change color, becoming pale and sickly looking. Meanwhile the stem mother continues to suck out their juices, grows, changes her skin two or three times, and after a few days begins to produce a family, with which she stocks the cavities of the curled leaves. They are little green things, and are produced alive, so that no time is wasted in getting them set to work at the task of tapping the leaves of their juices. Some of these members of the second generation remain on the leaf which was their birthplace, but others crawl off to neighboring leaves; ultimately they produce viviparously another set of offspring, at first similar to themselves, but destined to advance to a higher grade of development. By successive moultings they first ac-

quire the rudiments of wings, and at length become fully equipped with four delicate transparent wings. These winged forms are all of the same sort, and all have the power, like their predecessors, of producing living young. They are known as "emigrants," because they soon make use of the power of flight which they possess, and float away to other trees, thus spreading their ravages over a wider area. By this time, then, we have a large number of creatures as the descendants of a single egg, spread far and wide, and yet no other egg has thus far appeared, nor, indeed, will do so till the end of the summer.

These winged emigrants do not live long, but each gives birth to about a dozen living young, at intervals of about half an hour, and then dies. We are now in the fourth generation, and these new creatures are very different from those that have preceded them, being wingless and very active. When first dropped they look much like eggs, and have to shed a thin skin before they can move their limbs; the casting of this membrane enables a number of minute hairs to shoot rapidly out from the surface of the body, and thus we have a kind of transformation scene going on, a little shining yellow stationary object changing in about half a minute to a hairy, six-legged creature, which runs about quickly and soon covers itself with a kind of cottony down. Another generation of wingless creatures is again produced from these, and then we come in the sixth generation to something like the emigrants again, *i. e.*, the members of this grade gradually acquire wings; but their function is quite different from that of the emigrants aforesaid, for they are to become the parents of the true males and females which, in the next generation, will appear for the first time. These winged creatures are smaller than the previous set, and are called by the rather inappropriate name of "pupa bearers." They get their wings in July, and quickly make good use of them to wander in search of suitable places for the deposition of their brood. They settle on the bark of the selected elm trees, and there give birth to two sorts of beings, both exceedingly minute, and yellowish or orange in color. These, which constitute the seventh generation, are the true sexes. Their sole function is that of reproduction, and hence all their energies are bent to this purpose. They take no food, and, in fact, the female has neither beak nor mouth, and her partner is almost in a similar predicament, for, though he is born with a beak, he soon loses it and becomes as mouthless as his mate.

After having paired, the female establishes herself in a crevice of the bark, and there lays her single egg, which is large enough to occupy the whole of the cavity of her body. Having done this, she, or rather all that is left of her, at once dies, though she may, as we have said above, die even without depositing her burden, leaving it enshrouded in her withered skin. Thus, after having passed through a pedigree of seven successive generations of beings, we find ourselves back again at the stage with which the cycle commenced. The eggs lie on the trees throughout the winter, and next season the same series is gone through again. From a history such as this, it follows, of course, that by far the greater number of aphides seen during any particular summer do not originate from eggs at all, and that, indeed, when compared with the number of living beings produced altogether, the total number of eggs is ridiculously small.

Now, it is evident from the above that galls which are produced by insects of this sort differ in many respects from those which have previously occupied our attention. In the first place they are not associated with their fabricators throughout the whole cycle of their varied existence, but only during certain stages. Again, it is not the true female of the species, but the stem mother, that originates these aphis galls, and they are used by her and her immediate progeny till the migrating stage is reached. Moreover, the original puncture which started the gall is not made, as has always been the case hitherto, for the lodgment of an egg, but simply for the obtaining of food. In fact, no egg is ever associated with the gall at all. The galls produced by the different species are of various shapes and sizes, and, as they shelter communities, not individuals, their size bears no relation to that of the individual aphides. Some are as large as hazel nuts, and some occasionally reach the size of a ripe fig. They are found frequently on the stalks of leaves. Sometimes they rise from the blade of the leaf itself. They are hollow, and have an opening at the end, out of which the winged "emigrants" escape. If opened, they are found to contain not only a company of aphides, but a globule of sweetish liquid as well, and a quantity of a white mealy powder, with which also the bodies of the insects are dusted. The nature of the liquid and its exact relation to the inhabitants of the gall is doubtful. It is often too large in amount for there to be a possibility of its being entirely a secretion by the insects, and some naturalists suppose it to be in part, at least, exuded sap, which has escaped through the many punctures inflicted by the aphides upon the walls of the gall. The mealy powder clings to the surface of the globule, and thus prevents it from injuring the delicate insects among which it lies. According to Dr. M. C. Cooke, liquid of this sort found in large elm galls is collected in France and used, under the name of "elm water," as a lotion for sore eyes.

Nothing more beautiful can be imagined in the way of galls than those made on the spruce, fir, and larch, by aphides belonging to the genus *Chermes*. They closely mimic fir cones, so closely, in fact, that a section needs to be made before one can be convinced that they are not a legitimate fruit of the trees. They are, of course, smaller than the actual cones, and this would help to distinguish them were it not that they are so strongly suggestive of young cones. The life history of the creatures is less intricate than that detailed above, and only a few points need be noticed. The mother of the tribe starts the gall, but she does not produce living young. She lays a number of eggs, which are attached to the tree immediately around her body, each by a thread-like stalk. The larvæ hatched from these by their punctures increase the growth of the gall, and cause the adjacent leaves to swell so much as to meet one another at certain spots and inclose the insects within cavities. In this way a many-celled structure is built, which externally resembles a miniature fir cone. As time advances, the cone dries up, and its component scales then open out so as to leave free exit for the contained insects.

Only one other instance of gall growth need now be referred to, and with it we revert to the type which formed our earlier illustrations, viz., gall formation on the insertion of an egg. But, though the type of gall is similar to those formerly described, the insect cause is totally different, belonging to an order we have not yet had occasion to mention, viz., the Coleoptera, or beetles. It is an agricultural pest, known as the cabbage gall weevil. This insect is a stumpy, hard-skinned, black-bodied beetle, with a long, slender, curved beak, half way down which are inserted the elbowed antennæ. The mouth is at the tip of the beak, and here are situated a minute pair of jaws, with which the little pest can pierce the skin of a cabbage stalk. The beetle is by no means a large one, being only about one-eighth of an inch long from tip of beak to end of body. When it is alarmed it tucks its beak under its body, which is slightly grooved for its reception, and folds its legs up closely, so that its size seems much reduced, and it resembles a little lump of dirt.

The female insect with her beak pierces that part of the cabbage stem which is below ground, and lays an egg in the hole. Many such holes may be formed by the same beetle near together on the same stem. A gall soon forms round each puncture, and sometimes quite a cluster of rounded knobs may be seen on the stem. The egg hatching produces a footless maggot, which lives on the material of the gall. When it is full grown it gnaws its way through the rind of the gall and works itself into the earth, where it fashions a little cell in which it turns to a chrysalis; this becomes a perfect beetle the next season. In all its stages it is a very hardy insect, being able to endure a good deal of interference with its comfort without evil consequences. It will even survive being frozen stiff when in the pupal condition. Though these galls are small, they may become harmful by exhausting the plant, when present in great numbers. Not only the cabbage crop, but turnips also are subject to their attacks, though they seem less injurious in this case. This little beetle, which, if allowed to multiply too greatly, might become a serious pest, has had bestowed upon it a name by no means commensurate with its diminutive size, for in our cabinets it stands ticketed *Ceuthorhynchus sulcicollis.*—*Knowledge.*

A NEW SUN DIAL.

WE usually imagine the sun dial to be a complicated affair, difficult to trace out, almost a souvenir of the middle ages. Can we find an artisan capable of performing this work? We all know that it constitutes quite a complex problem of geometry, and the solution is exact only one time in a hundred. Scientists, it is true, have accumulated the difficulties in this problem to their hearts' content, perhaps solely for the purpose of making an exercise for their pupils. Let us reduce it to its simplest expression, and it becomes of infantine simplicity.

Instead of trying to ascertain what will be the shadow of a style upon any plane whatever, let us select the plane and put it in the position that best suits our purpose. Such is the principle of the invention that we are about to describe.

Suppose, then, a divided dial placed parallel with the equator, and in the center of such dial a perpendicular style. It is evident that the sun, revolving around this style in its apparent motion, will project the shadow of it upon the divisions, successively and proportionally to its travel. It will be the same whether the dial is at the equator, at the poles, or in any intermediate place whatever (Fig. 1).

Here we have the apparatus constituted on condition (1) that the dial be placed in a plane exactly parallel with that of the equator, (2) that the style be exactly at right angles with it, and (3) that the origin of the graduation be brought into a proper azimuth.

Let us suppose that the sun is situated in the northern hemisphere; we are in summer. For the European observer, the shadow of the style is then projected upon the upper surface of the apparatus. Then the sun approaches the plane of the equator. Starting from this moment, it is the lower surface of the dial that is illuminated and that receives the shadow of the style, or rather of its prolongation. One would, therefore, be obliged to stoop beneath the apparatus in order to effect the reading. Mr. Chamberland has overcome this slight inconvenience in a very simple manner. The internal edge of the dial (Fig. 2) is turned back for a width of a few millimeters, so that when the sun is illuminating the southern hemisphere, the shadow of the style falls upon this flange, opposite figures inscribed upon the upper surface.

Let us now examine the details of the apparatus. It consists essentially of a circular sheet of metal (Fig. 2) with an appendage, M N, forming a rectilinear base opposite the figure XII (midday). The lower part contains an opening, whose edge is turned back according to a circumference concentric with the first. Finally, exactly perpendicular to the plane of the dial there is fixed a reglet, A A^1, so that its lower edge passes exactly through the center of the two circumferences. This edge constitutes the style whose shadow is to traverse all the hour divisions.

From what precedes, it will be understood that the first operation should consist in placing the dial in a plane parallel with that of the equator. We employ a very horizontal plane, which forms with that of the equator (Fig. 1) a complementary angle of the latitude of the place, and, according to the theorem of internal alternate angles, makes the same angle with the plane of the dial, parallel with that of the equator.

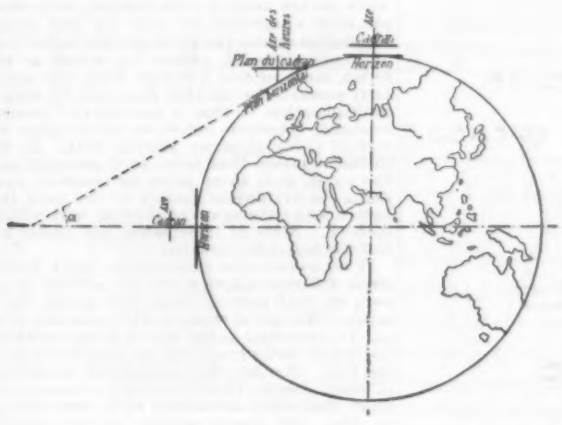


FIG. 1.

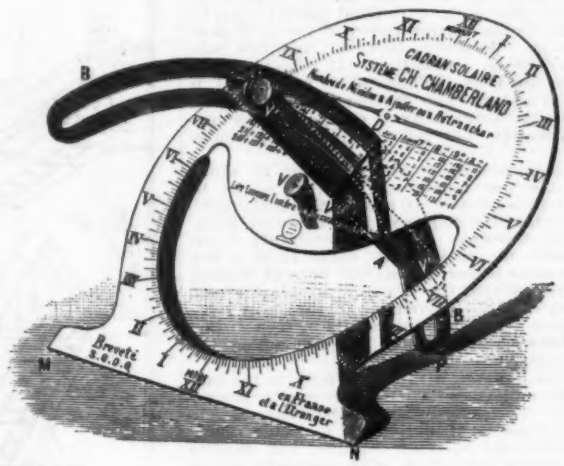


FIG. 2.

THE CHAMBERLAND SUN DIAL.

Now, it is very easy at the present time to ascertain the latitude of the place that one inhabits, say from a map. Supposing the dial carries a graduated quadrant, B D B (Fig. 2), having for a center the lower edge of the dial and movable around such center, it will suffice to count upon this quadrant from its foot, a number of degrees equal to a and to make the extremity of this arc coincide with the plane of the dial. But then the part of the quadrant comprised between its head and the plane of the dial is the complemental of a, that is to say, is precisely equal to the latitude of the place. This is what the inventor has done in inscribing the 0 of the graduation, not at the bottom, but at the top of the arc of the circle. It will be seen, too, in Fig. 2, that the quadrant is connected with the dial by two screw buttons, V V', placed at the extremities of the reglet, A A^1. After the dial has been fixed at the desired inclination, the apparatus is capable of occupying a multitude of different positions upon the horizontal plane that serves it as a support. Particularly, if the figure XII (midday), which is situated at the center of the base, M N, remains fixed upon the horizontal plane, these positions will constitute the envelope of an upright cone. We may, likewise, say that the line, XII—XII (midnight—midday), describes the same cone.

It is a question of placing this line, XII—XII, in the meridian plane, or according to the north-south line. Now, processes are not wanting for the determination of such line — the compass, an observation of the shadow of a fixed bar, the polar star, if need be, etc. Still, we speak of elementary processes only.

After the north-south line has been once traced upon the horizontal plane, the perpendicular or east-west line is to be marked, and the base of the dial be made to coincide, care being taken to direct the figure XII (midday), which is situated at the base, toward the north.

The apparatus is installed, and the shadow of the lower edge of the reglet indicates the hour upon the dial, but it is the *true* hour of the *place* where it is installed. We know the difference existing between the true and the mean hour indicated by watches and clocks. Ordinarily we employ only the latter, while the apparatus indicates the other. It would be necessary, therefore, to possess a table giving for every day of the year the number of minutes to be added to or subtracted from the reading made. Every day of the year, that is much; every five days is quite sufficient. Mr. Chamberland has taken care to place this reduced

table upon the upper surface of the dial, right under the eyes of the observer.

This instrument may likewise be used for calculating the length of the day and night at a given date.—*Le Genie Civil.*

THE NEW EXCAVATIONS AT TROY.

OUR readers are already aware that the excavations at Hissarlik, brought to an untimely end by the death of Dr. Schliemann, in 1890, were resumed this year by Dr. Dorpfeld, the necessary funds being placed at his disposal by Mme. Schliemann. The work was begun on May 1, and went on to July 11. Dr. Dorpfeld took with him as coadjutors—for architecture, Herr W. Wilberg; for Greek archæology, Herr A. Brueckner; and for prehistoric remains, Herr R. Weigel. The full publication of the discoveries is to appear in the course of the winter; meantime, a provisional report is published in the last issue of the *Athenian Mittheilungen* (Band xviii., zweites Heft).

We are glad to see that the results of the expedition have considerably exceeded the hopes entertained. What precisely these results are will best be understood by a brief *resume* of the state of the case when Dr. Schliemann closed his work in 1890. In the Ilios, or Troya, it will be remembered, seven strata or cities are noted and described. Dr. Schliemann's last excavations increased the seven to nine. Besides the sixth, or, as he called it, Lydian stratum, and the seventh or Roman one, two other strata came to light, which, from the objects found in them, unmistakably belonged to respectively early and late Greek dates. A further result of the 1890 excavations was that the date of the sixth stratum was fixed, and two buildings of substantial dimensions found within it. Besides the so-called Lydian pottery he found in this sixth stratum there came to light a mass of fragments and some whole vases of the Mycenæ ware. From this it was deduced, and rightly, that in the sixth stratum, to which hitherto but little attention had been paid, we have a civilization contemporary with that of Tiryns and Mycenæ. It was tempting to go further and see in this stratum the city of the Trojan war; but as two buildings only had been brought to light, and no city wall could with certainty be identified, it was felt that till the sixth stratum was fully explored any such conclusion would be rash. The city lying two strata beneath, with its imposing remains of dwellings, city walls, towers, and gates, had strong claims to preference, but the objects found within that stratum were inconveniently primitive and distinctly pre-Mycenean.

This doubt, this divided claim between the second and the sixth stratum, to be the Homeric Citadel, has been by the recent excavations completely set at rest. The sixth stratum, of which a considerable part has been completely excavated, has shown itself to be the most imposing fortified citadel that ever—previous to Roman days—occupied the hill. The remains of seven large buildings have been laid bare. Their ground plan is something like that of a Greek temple, and of the *megara* of Tiryns and Mycenæ, but their proportions are larger and the masonry superior. The most striking of the buildings discovered is a large hall situated about the middle of the citadel. The hall itself is 9 meters broad by 11½ long, and is furnished with a portico, oriented N. W. From the remains of stone bases the hall seems to have been divided by three wooden columns into two naves; it seems, in fact, to have closely resembled the temple excavated by R. Koldewey, at Neandria. Whether the building at Hissarlik is actually a temple or not, cannot at present be decided.

The citadel of this sixth stratum is fortified by a wall 5 meters broad, and in some parts still standing several meters high. The northeast corner is faced by a massive tower about 18 meters in width, and still standing over 8 meters high. In size, solidity, and finish of work, this tower is second to none other of Greek date—in fact, so admirable is the masonry that suspicion might have arisen that it was of historical date; but fortunately in parts it can clearly be made out that in historical times it was added to and built over. Within the seven buildings of this sixth stratum have been found abundant remains, not only of the local Lydian ware, but also of Mycenæ fragments; moreover, between this sixth stratum and the one of Roman date, two intervening strata are clearly to be made out, hence it seems evident that in the sixth stratum, if anywhere, we have the veritable Homeric remains. Its area is about that of the citadel at Tiryns, and is at least double that of the city of the second stratum. It stands about 28 meters above the plain.

Whether to this citadel there corresponded a lower city in the plain, as is the case at Mycenæ, is as yet undetermined, but from tentative excavations made it seems probable. About three-quarters of mile south of the Acropolis a quantity of Lydian fragments were found, and mixed with them Mycenæ pottery, and one urn came to light of pottery corresponding to that of the sixth stratum and with traces of burial by burning, and which, of course, all agree well with Homeric methods.

Supposing that the sixth stratum *is* the Homeric Troy, it follows, of course, that the substantial city of the second stratum must go back to a date earlier than that of any similar European structures—probably to 3,000 years B. C.—and even earlier must be the primitive settlement of the first stratum. In order to satisfy himself that the stratification thus arrived at was really correct, Dr. Dorpfeld sank a small shaft on a portion of the hill still untouched; in this experiment he proceeded with precautions unfortunately neglected on Dr. Schliemann's work. As each layer was reached, its contents were noted, and before any masonry was removed to reach the next layer it was measured, drawn, and photographed. The result was that the consecution of strata noted in 1890 was completely confirmed, even to minute subdivisions. For clearness sake we give the strata as now established, divided, as Dr. Dorpfeld classifies them, under three main heads:

I. Pre-Mycenean or pre-historic strata.
- (*a*) Primitive settlement = first stratum.
- (*b*) Imposing fortified citadel with dwelling houses, citadel walls, towers, gates = second stratum.
- (*c*) Three unimportant settlements erected on the ashes of the second stratum = third—fifth strata.

II. The Mycenean stratum or the Homeric Bergamos = sixth stratum.

III. The post-Mycenean strata.
- (*a*) Archaic dwelling houses = seventh stratum.
- (*b*) Græco-hellenistic dwelling houses = eighth stratum.
- (*c*) Imposing Roman structures = ninth stratum.

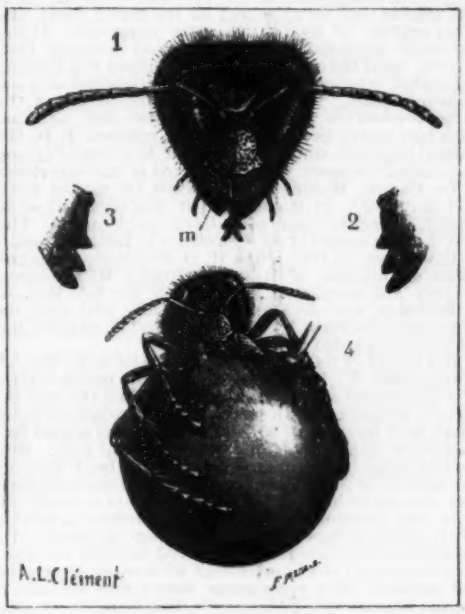
We have given here an abstract of the report in the *Mittheilungen*—the opinions are those there expressed—till the actual material is published independent opinion will necessarily be impossible. On his own supposition that the sixth stratum is the Homeric Troy, Dr. Dorpfeld is full of natural regret that Schliemann himself did not live to see the palaces of Troy exhumed. He did see the first structure discovered, and a few Mycenæ vase fragments, and recognized their importance. Much of the sixth stratum still remains undiscovered, but we are not told if Mme. Schliemann continues next year her work of pious memorial.—*The Builder.*

WASPS AND GRAPES.

WE have on several occasions reproduced from the *Revue Horticole* the discussions that have taken place among horticulturists or naturalists on the question as to whether wasps are themselves capable of puncturing grapes or whether they merely profit by incisions previously made by birds or through some accidental cause.

After some contradictory articles, Mr. Ricaud, who has made numerous observations, asserts that wasps attack only such grapes as have already been punctured. Mr. Salomon reaches the same conclusion. Wasps, says he, attack grapes only after they have been perforated through other causes.

Mr. L. Henry does not partake of the same opinion, and we give here the last letter that he published on this subject in the *Revue Horticole*. After stating that he has seen wasps puncture the skin of grapes—a fact that he has determined by experiment—Mr. Henry adds: As regards depredations upon vine arbors, I have never put in doubt the preference of wasps for grapes already punctured. But, without claiming that such is always the case, I maintain, on account of having established the fact in a precise manner, that last year the wasps did not content themselves with grapes that were already perforated, but, in various places, punctured them themselves. In the presence of the affirmations of Messrs. Ricaud and Salomon, I invoke the testimony of Mr. Rouland, *chef de pratique* of the National School of Horticulture of Versailles, and that of Messrs. Jouin, of Plantieres-les-Metz, and Laurent, professor at the School of Horticulture of Vilvorde and at the Agricultural Institute of Gembloux.



WASP'S HEAD AND DETAILS OF MANDIBLES. (Greatly magnified.)

1. Front View—*m*, mandibles at rest. 2. Denticulation of a mandible above. 3. The same underneath. 4. Wasp clasping a grape—the mandibles are open and endeavoring to pierce the skin.

In a letter of the 19th of November, 1892, the last named says that, in the opinion of Mr. Joris, wasps frequently attack grapes without having recourse to assistants, and that my observation was then confirmed by that of Mr. Emile Jouin, who wrote from the St. Louis nurseries under date of the 29th of November, 1892, that his father had remarked that year that the wasps had not only attacked fissured fruits, but had thoroughly punctured the most intact ones, and not only pears and grapes, but also peaches. These contradictory opinions, emanating from persons of equal authority, leave the question undecided. The sole point of knowing whether wasps are so organized as to be able to puncture fruits themselves is elucidated affirmatively by my direct and precise experience. On the one hand, the wasps themselves puncture grapes, at least they did so last year at Versailles, Plantieres, Vilvorde and elsewhere; and on another hand, at Beaune and Thomery they sucked only such grapes as had already been punctured through other causes.

In the presence of such contradictory opinions, given by equally competent persons, we are unable to formulate a personal conclusion; but this year there are many wasps and many grapes, and there is, therefore, a unique occasion for observers. While awaiting a solution of the problem, we have thought that it would prove of interest to give a figure of a wasp's head magnified. It will be found that the insect's mandibles are fleshy. It would seem as if they did not offer enough consistence to easily perforate a grape, as is shown in No. 4 of the figure. It is a simple observation that we offer. We shall await a definite solution of this much-discussed question.*—*La Nature.*

THE OIL-PRODUCING PLANTS OF FORMOSA.*

SINCE the introduction of kerosene oil into China the demand for native lighting oils has been on the decline, but for cooking purposes some of these oils are produced in large quantities. Oil-yielding seeds are likewise exported, to a limited extent, to foreign countries, where the oil is extracted and used to adulterate more valuable oils.

Of the 17 oil-producing plants cultivated in China, 8 grow in Formosa. They are:

1. *Dolichos soja*, L. (?)—More oil is extracted from this bean than from any one of the other oil-yielding plants of China. The two kinds of bean treated for oil are small in size and oval in shape, one having a whitish-yellow epidermis and interior, the other being green throughout. They are probably sub-varieties of the *soja* bean. The process of extraction is worthy of description.

The beans are first crushed under a huge stone wheel. They are thus flattened into thin round wafers, and are crushed a second time before they are ready for further manipulation. After the second crushing, bean wafers sufficient to make a cake 4 in. thick and 2 ft. in diameter when compressed are put in a square piece of sacking, and placed on a wooden grating above a caldron of boiling water. In a few minutes they are rendered quite soft by the steam, which passes up through the grating to the sacking and its contents. During the process of steaming, another workman has been arranging a series of soft straw brooms, which are also steamed, so as to form the bottom of a couple of narrow metal bands surmounted by a wooden casing, over which the long tips of the straw broom project. Into this the steamed beans are poured and trampled down by foot till the mass is quite hard. The projecting straw tips are then brought over the top of the beans by foot and trampled down so as to form a covering. The wooden casing is removed, and the metal bands arranged a short distance apart near the top and bottom of the cake respectively. The whole is then put into a primitive wooden press, and subjected to considerable pressure by the driving in of successive wedges. The oil is expressed and drains into an underground tank, the top of which is on a level with the stone-guttered slab on which the lowest cake rests, for half a dozen cakes, one above the other, may be undergoing pressure in the same press at the same time. When all the oil has exuded from the cakes, they are taken from the press, the metal bands and straw casings are removed, and, after being left to dry for a time, they are ready to be shipped to other parts of China for manure. The beans yield about 10 per cent. weight of oil, and the cakes, when removed from the press, weigh some 64 lb., and are worth about 2s. 9d. each. They constitute a very valuable manure, and are carefully macerated before being applied to the soil.

To show the commercial value of this industry, the author mentions that 60,000 tons of bean cakes were exported from Chefoo during 1890. Nor is Chefoo the principal exporter. Newchwang sent out over 156,000 tons in the same year. In Formosa these beans are grown, and the oil is extracted in the above manner, but only in quantities sufficient to meet local requirements. The refuse cakes are not exported. The oil is used for both cooking and lighting purposes.

2. *Brassica Chinensis*, L.—Rape is usually a winter crop in China. Toward the end of October the seeds are planted about a foot apart in beds; in March the plants are in full flower, and in early June the crop of seeds is harvested. This refers to Mid-China, where the temperature is mild and the frost is not so severe as to retard sowing till after winter. It is more widely cultivated in China than any of the other oil-yielding plants. The seeds are treated much in the same way as beans, being crushed, steamed, and subjected to pressure. Like the preceding, rape oil is used for lighting as well as for cooking.

3. *Sesamum Indecum et Orientale*, D. C.—Both the white and black seeded varieties of sesame are cultivated in China, and from Formosa there is a very considerable export of seeds which find their way to France, where sesame is largely used to adulterate olive oil. It is a summer crop; the seed is sown in May, usually in rows with other crops, such as cotton on the mainland; the plant blossoms in July, and the harvest takes place in September and October. Sesame is essentially a food oil. Refuse seed cake is much used in Formosa for adulterating opium.

4. *Arachis hypogæa*, L.—The ground nut, a native of Africa, is extensively cultivated in China, not only for the food which the nuts supply but also for the oil which they contain. Although the Chinese have not yet discovered a good practical method of removing the shells before pressing, yet the oil, necessarily impure on that account, is highly appreciated as a food, as well as a lamp oil. To obtain the oil, the nuts are roasted, rolled, winnowed—to get rid of the shells—steamed and pressed. The plant prefers a sandy soil, such as is found in the neighborhood of Chefoo, but it appears to be equally at home in Western China and in Formosa. The author states that these nuts are found on every roadside stall in China.

5. *Stillingia sebifera*, S. and N.—From the seeds of the vegetable tallow tree, both tallow and oil are produced. They are used for lighting purposes only, and as the method of extraction is ingenious, a short description thereof may be of some interest. When the fruit is ripe the dark brown protecting covering which encircles each seed opens and falls to the ground, leaving exposed bunches of grayish-white berries, which resemble coffee beans in appearance and size. These are collected by hand, steamed and thereafter pounded

* We have stated that wasps have been very numerous for a few months past. One of our correspondents writes us that he has constructed some very efficient wasp traps. He takes a goblet, at the mouth of which he places a tin funnel. As a bait, he coats the interior of the funnel with sirup, and some of it is poured into the glass with a little water. The wasps enter the liquid and are drowned therein. The use of petroleum or of bisulphide of carbon is recommended for the destruction of wasps' nests.

† Alex. Hosie, Consular Rep., No. 11, 1893.

in an ordinary rice trough. By pounding, the soft mealy mesocarp is partially separated from the kernels. The whole is then placed in a bamboo sieve, the meshes of which are just large enough to allow the mealy matter to be scrubbed through, and small enough to keep back the kernels, which are hard, black, and about the size of peas. From the mealy substance the tallow is expressed in primitive wooden presses. The oil is derived from the kernels in the following manner: They are dried in the sun and pressed between two mill stones held at such a distance apart, by means of a bamboo pivot, as to crush the hard shells of the kernels without injuring the white interiors. The whole is then passed through a winnower, which separates the broken shells from the solid matter. The latter is thereafter placed in a deep iron pan over a fire, the crushed oily shells making an excellent fuel, and roasted till it begins to assume a brownish color, the process being accompanied by continual stirring to prevent burning. It is then crushed by a huge stone roller in a circular stone well, steamed, made into cakes, like cheeses, with bamboo and straw casings, and passed through the wooden press. The resultant is a good lighting oil of a brownish yellow color.

In Formosa this tree is utterly neglected, but in the great centers of tallow and oil manufacture in China it is grafted, and, consequently, yields superior fruit.

6. *Camellia thea*, Link.—In all the tea-growing districts throughout China, the seeds of the tea plant not required for raising new bushes are collected and treated for their oil, which is employed for both food and lighting.

7. *Cinnamomum camphora*, N. and E.—Although the camphor laurel is found in many of the provinces of China, where it is highly valued on account of its wood, yet Formosa is the only province in which camphor is manufactured. When the camphor is being distilled from the chips of camphor wood, an essential oil exudes and drops into the boiling water underneath. This, as well as the liquid which exudes from the camphor when awaiting shipment, is collected and exported under the name of camphor oil.

8. *Ricinus sp.*—The castor oil plant grows wild throughout Formosa; but in the north of the island oil is not extracted from the seed, nor is any use whatever made of the plant. In the south a little oil is extracted for purely local uses, but no attempt is made to cultivate the plant. The species, which has green stems and leaves, does not attain the height of *Ricinus communis*, which is distinguished by its purple stems, branches, and leaves. The latter, grown from imported seed, may be seen as an ornamental shrub in gardens near Tamsui.

Diospyros kaki, L. f., grows in Formosa as well as on the mainland. The juice of its fruit should be classed as varnish and not as oil.

VANILLA CULTIVATION IN MEXICO.

AT the time of the conquest of Mexico, the Aztecs used the vanilla for flavoring chocolate. The Spaniards learned its use from them and introduced it into Europe. Gathered at first from the vines growing wild in the forests, its cultivation as a special industry became profitable, though just at what date there are no records to show; but we find that as early as 1760 there were *vainillales*, or vanilla plantations, in the vicinity of Papantla.

A native of eastern Mexico, this plant grows wild in the state of Vera Cruz, from one extremity to the other of its coast line, and from the sea beach up to the mountains of the Sierra. It is cultivated mainly in the cantons of Misantla and Papantla, in that state, the little that is produced in Oaxaca being for the most part gathered from the vines which grow wild and uncultivated in the forests.

The vanilla plant belongs to the orchid family, has a pulpy stem, which grows to several yards in length, attaches itself to trees, and appears to be little dependent on the soil for nourishment. The leaves are lanceolate and pulpy, and the yellow flowers bud from the axilla formed by the leaves with the stem. The fruit is a pod from six to twelve inches long, and about half an inch in diameter at its thickest part, tapering down toward the stem, curved in its entire length, dark green in its earlier stages, and yellow when fully ripe. It is filled with minute black seeds, somewhat resembling iron filings. When prepared for market, the pod becomes reduced to about a quarter of its original thickness, is black in color, and, it is needless to say, emits a very agreeable perfume.

Six varieties of vanilla are known in Mexico, namely, the mansa, the cimarrona, the mestiza, the pompona, the puerco, and the mono. Of these the mansa is the only one cultivated. The cimarrona, or wild vanilla, has a more pointed leaf and a thinner vine than the mansa; the pod is shorter, rounder, and thinner. The mestiza has more pointed leaves than the mansa, but less so than the cimarrona; the size of the pods is smaller than those of the mansa and larger than those of the cimarrona. This variety is scarce, and when prepared it can hardly be distinguished from the mansa. The pompona (*siguexanle* or banana vanilla, as the Totonaco Indians, who occasionally eat it, call this variety) has larger and rounder leaves, and a vine one-half thicker than the mansa; the pod is double the size, and triangular in shape, resembling somewhat a badly nourished plantain: it has an extremely pleasant smell, not unlike anise, and is used in Havana by the tobacco manufacturers to mix with cigars. The puerco and mono, which grow wild and resemble the cimarrona, are not used in commerce.

There is yet another vanilla, called the tarro, or bamboo vanilla, which is considered by many as a distinct species, but is really nothing else than the mansa grown in the *tarrales* or bamboo thickets in the depths of the virgin forests, where it does not receive a sufficiency of sun and air, and produces a pod thinner and longer than the ordinary mansa.

The vanilla buyers formerly divided the prepared bean into four classes, namely:

1. The beans or pods from six and one-half inches long and upward, short in the neck or stalk, sound and black; the beans which become split or open, provided they have the foregoing qualities, and the split does not extend more than one-third of the pod. This class was again subdivided into *terciada*, which is composed of the shortest pods; *primera chica*, which contains the next in size; *primera grande*, the next; *marca menor*, the next; and *marca mayor*, the largest of all.

2. Those pods which differ from the *terciada* only in being shorter, two of them counting as one of the first class.

3. *Zacate*, or the pods of all sizes which are imperfect through being gathered before becoming properly ripe, or being over-cured, *pescozuda*, *vana*, *cueruda* and *aposcoyonada*, all names for pods in a more or less damaged condition; and *cimarrona* or wild vanilla in good or fair condition, three pods counting as one of the first class.

4. The *rezacate*, composed of the very short pods; of those split clear up to the stalk; of the badly damaged; of the very immature; and of the very much over-cured, which resembles a piece of wood; of this fourth class, six pods counted as one of the first class. The quantity of this and of the second class was always very limited.

At the present day, the only distinction made is between the best class and the cimarrona and rezacate, the last two being sold at a very much lower price than the former. Both buying and selling are carried on by count.—*Revista Financiera Mexicana.*

BLEEDING BREAD.

THE phenomenon known in Germany as "Blut im Brode," and to us as bleeding bread, has appeared in this country, to no little dismay of the peaceful inhabitants. The subjects of this visitation are not only bread and biscuit, but also boiled potatoes, rice, and other farinaceous substances, on which red stains appear, which resemble blotches of blood. In former times, before their nature was known, these blood stains created much consternation among the superstitious as portents of calamity. The first modern naturalist who described it in scientific terms was Dr. Sette, of Venice, who recorded its appearance in Padua, in 1819, and gave it the name of *Zoogalactina imetropha*. In this instance it is stated that "a peasant of Liguara, near Padua, was terrified by the sight of blood stains scattered over some polenta which had been made and shut up in a cupboard on the previous evening. Next day similar patches appeared on the bread, meat, and other articles of food in the same cupboard. It was naturally regarded as a miracle and warning from heaven, until the case had been submitted to a Paduan naturalist, who easily recognized the presence of a microscopic plant."* Subsequently Ehrenberg saw the same production near Berlin, in 1848, and, as usual with him under like circumstances, referred it to the animal kingdom, under the name of *Monas prodigiosa*, but during the same year it occurred in the experience of Dr. Camille Montagne, who saw it on cooked fowls and cauliflower, at Rouen, and it was regarded as an algoid, under the name of *Palmella prodigiosa*. The first definite record of its occurrence in Britain appears to have been in 1853, when H. O. Stephens communicated an account of it to the Bristol Microscopical Society, and submitted specimens to the late Rev. M. J. Berkeley, who declared it to be identical with the organisms described by Ehrenberg and Montagne, but which he regarded as a fungus.

The record of its appearance at Bristol is to the following effect:† "I observed at table the under surface of a half round of boiled salt beef, cooked the day before, to be specked with several bright carmine-colored spots, as if the dish in which the meat was placed had contained minute portions of red currant jelly. Suspecting what these might turn out to be, I directed the beef to be placed aside. On examination the next day the spots had spread into patches of a vivid carmine red stratum of two or more inches in length. With a simple lens the plant appears to consist of a gelatinous substratum of a paler red, bearing an upper layer of a vivid red hue, having an uneven or papillated surface. The microscope shows this stratum to consist of generally globose cells, immersed in, or connected by, mucilaginous or gelatinous matter. The cells vary in size, and contain red endochrome; they seem to consist of a single cell membrane, and contain a nucleus. Treated with sulpho-iodine they become blue."

As to its place in the organic kingdom, Mr. Stephens was of opinion that it was a *Palmella* closely allied to *Palmella cruenta*, but distinct, the cells or granules of the latter differing from it, not only in their color but size, being very much smaller than those of *P. prodigiosa*. As to its propagation, he farther remarks that it seems to extend itself by elastically spurting a sort of jet or column of red particles, which Berkeley compared to a jet of blood from an artery, and by this method it was suggested that the extraordinary rapidity with which a large surface becomes covered can be explained. The vitality of the cells is not impaired (within a certain time) by desiccation, even at a high temperature, and when dry they retain their germinating powers for a considerable period.

The spherical cells are filled with a reddish oil, which gives to them a peach blossom tint, and when transferred to raw meat they assume a splendid fuchsia color, resembling spots of blood. The plant is only developed in the dark, and the nitrogen necessary for its nutriment must be derived from the air, especially when developed upon bread. About 1886 an epidemic appearance on the Continent was attributed to this source. Pieces of cooked meat presented a singular carmine red coloration, and stained vividly the fingers or linen with which they came in contact. These phenomena prevailed regularly for a period of three months. Food cooked overnight was found the next morning covered with red patches, and it then underwent rapid alteration. Coincident with a sudden and considerable fall in the temperature the epidemic ceased, and did not reappear.‡

Fresenius records the result of his examination of this organism, in his "Beitrage," to the effect that "he took four boiled potatoes, and placed them in a drawer, having previously rubbed two of them slightly here and there with the red substance. After about twenty-four hours the two potatoes which had not been rubbed, and which had not been in immediate contact with the other two, were affected with fresh spots of the red substance, while the spots upon the two which had been rubbed had increased in extent. The spots showed themselves in the form of irregular groups of blood red drops of different size, which in some places were distinct, and in others had run into one another. The individual bodies of which the spots consist are mere molecules, their diameter varying from one two-thousandth to one four-thousandth of a line. They are mostly round, occasionally oval, and sometimes slightly contracted in the middle, by way of preparation for increase by division into two small round cells. By far the greater number of them, when brought under the microscope in a drop of water, remain at rest—they lie close together in large numbers; when they are more dispersed in the fluid, they have a motion which is not distinguishable from ordinary molecular motion. When the drop of water moves, they are carried mechanically over the stage like other molecules, and when this motion ceases they remain at one spot in a sort of quivering state until a fresh current carries them in another direction. If the eye be kept carefully upon a part of the stage where the small bodies are thinly dispersed, it will be observed that they passively follow the current of the water, nor, when the current has become sluggish, or has even altogether ceased, are individual bodies ever seen to detach themselves from the group, and take a contrary direction, which real monads would do with great activity."

The present determination of this organism, according to some, is *Micrococcus prodigiosus*, but according to others it is *Bacillus prodigiosus*, and consequently one of the *Schizomycetes*. It has been pointed out that as the temperature rises this *Bacillus* loses its power of forming a pigment, and if it is grown on potato or bread paste, in an incubator at blood heat, instead of at the temperature of the room, the color is gradually lost, and the culture no longer smells of herring brine, but the power of forming lactic acid from milk sugar, with the accompanying precipitation of the casein, is frequently considerably increased; so that it would appear that the energy required for the building up of the pigment substance was in this case diverted into another channel, and lactic acid, and perhaps other substances, are produced in place of the usual pigment.*

The reappearance of this organism in this country, during the late hot weather, and especially on cooked potatoes, gives interest to its history, and is sufficient apology for these observations.—*M. C. Cooke in Nature.*

GREAT TELESCOPES OF THE FUTURE.†

By ALVAN G. CLARK.

I HAVE been asked by the local committee, through their secretary, to prepare a paper for the Astronomical Congress, embodying my ideas on the future possibilities in the construction of great telescopes. I accepted the invitation somewhat reluctantly, for, while I appreciate the honor extended to me, I feel that the subject chosen by the committee is a somewhat delicate one to deal with, as I may say many things which do not coincide with the preconceived ideas of some that may be present. I beg therefore that they will regard the subject of this paper as simply the embodiment of my ideas. I shall endeavor not to state anything as a fact that has not been demonstrated as such by repeated experiments.

Much has been written and more said regarding the great telescopes of the future. It seems to me that the best method of studying the subject is by a careful consideration of what has been accomplished with the instruments already made. From my personal comparisons I find that most of the important original discoveries in the truly visual line have been made with the largest telescopes in use at the time. In making this statement I would say that I do not include such discoveries as have been made from observed irregular proper motions of stars, such as, for instance, the companion to Sirius, which was known to exist some years before it was seen, although this required the largest refracting telescope then in existence to show it to the human eye. When once seen, however, with the large glass, it was readily seen with small ones. Nor would I ignore the many double stars discovered with smaller telescopes. These discoveries have been made with instruments of superior defining power, under fine atmospheric conditions, and are valuable contributions to astronomy, yet I do not believe that a small telescope was necessary to make these discoveries. I am of the opinion that had the discoverers had at their command the largest telescope, the discoveries would have been more numerous and important. When the two 15 inch telescopes were made in 1846, one for Pulkova, the other for the Harvard Observatory, they were considered monsters. I believe it was thought by most astronomers that the limit in size had been reached. No larger refracting telescope was made for a period of more than fifteen years, the next largest being an 18½ inch. I mention this fact to show how and at what time the demand for larger telescopes came. I think that the order for the 18½ inch was given in 1860. As soon as the companion to Sirius was discovered with this glass, at once there seemed to be a desire for something larger. The next larger telescope was made for R. S. Newhall, of Gateshead, England. Then came the 26 inch for the United States Naval Observatory, and then Leander J. McCormick presented the University of Virginia with one of the same size. After that the 30 inch for the Russian Observatory was constructed, and, finally, the 36 inch for the Lick Observatory. Besides, there is now in process of construction, and well under way, a 40 inch telescope for the University of Chicago.

I have always been a believer in large telescopes for special work. I have had great experience with them, and it is from testing these instruments that I have been convinced that large instruments are needed to make original discoveries, such as new satellites to planets, and faint companions to bright stars, in fact to any stars, as well as for studying the planets and nebulæ. For astro-physical work they are vastly superior to smaller ones. The trouble that early opticians

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* Trouessart, "Microbes," etc., London, 1889, p. 126.

† H. O. Stephens, on *Palmella prodigiosa* in *Annals of Nat. Hist.*, vol. xii., December, 1853.

‡ *Pharmaceutical Journal*, January 29, 1887, p. 610.

* Dr. G. S. Woodhead, "Bacteria and their Products" (1891), p. 9.

† Read at the Congress of Astronomy and Astro-Physics, Chicago, August, 1893.—*Astro-Physics*

experienced in procuring good disks of glass seems to have passed away, and we are now able to procure disks of almost any size, the only obstacle being the time required to make them, and the money to pay for them.

Having given you some of my reasons for believing in large telescopes, I will now proceed with the subject of this paper, viz., my ideas of the future possibilities in the construction of great telescopes. It is my idea that the great telescopes of the future will be refractors, not reflectors, and I shall confine myself entirely to the refractor. I would not wish to say anything that might lead you to suppose that I underestimate the value of the great discoveries made with reflecting telescopes, or the great minds that have made and worked with them, yet one person of eminence did remark that large reflecting telescopes have never accomplished much except in the hands of the opticians who made them; and my own experience has been sufficient to convince me that the reflector is extremely sensitive to any changes either of temperature, or air currents, or more particularly to flexure, and that while the refractor is also affected by these changes, it is by no means so injurious to the definition.

As I have said, I believe that good disks of any size, both crown and flint, may now be procured. Having once procured them, all that is required is an optician to work them. He must be an artist in light and shade, and in color also, for the very best correction of the chromatic aberration. As in the light and shade we search for and locate the spherical aberration, so we work among the different colors for the chromatic corrections. It is a very difficult task, and as the size is constantly being increased, the difficulties also increase. Personally I do not believe this work can ever be accomplished by machinery. Not that machinery might not be made available for the rough work and the first polishing, for we ourselves polish all our large surfaces in a machine in a preliminary way. The fine grinding and smoothing, however, is always done by hand. It is after the first machine polishing is done, and the glass appears to be finished, that what I have referred to as artistic work begins, that is, the work to locate the errors from observations, and correct the surfaces of the glass by the tentative method till all the light from a point at an infinite distance will be refracted to a point at the focus of the objective so accurately that the image there formed will bear the highest magnifying powers without showing any distortion. I believe that this can be accomplished only by most careful study of the light that has passed through the objective, and that all the errors must be worked out by what is termed local corrections.

When the time is ready, I think the man capable of making the necessary observations and locating the errors with precision, as well as skillful enough to work them out on much larger objectives than have yet been attempted, will be found. The simple preliminary grinding and polishing of large lenses is not a very difficult operation; this, with the centering, is purely mechanical. But if the glass itself has the slightest unevenness in its density, be it ever so small, the refraction will be different through the different densities. This cannot be determined with certainty until the disks have been worked into an object glass, or at least, ground and polished for that purpose. If, after this grinding and polishing has been done with the greatest care, we find the image produced by the lens which is achromatic is not symmetrical, and that a star at the focus is not round, but possibly is elliptical, rectangular, or in fact of any shape, what is to be done? After so much expense and labor, shall we condemn the glass, and wait perhaps years for other disks which, after going through the same process, may give no better result? I will state here that of all the large glasses, that is to say over 18½ inches aperture, that have been made by Alvan Clark & Sons, only one, viz., the Princeton 23 inch, came from the polishing machine giving a perfectly round image. All the others we had to round by local work.

I believe the optician that is to make the large telescopes of the future, as well as the present, must be able to do this work. In my opinion it is not more difficult than the correction of the spherical aberration proper, though if much out, it may prove more laborious. Surely I believe this work should be done rather than condemn the disks and try others. Each glass can be rounded separately. For this purpose set the combined lens in front of a collimating mirror. An artificial star is produced from a lamp by reflecting the light from a minute lens within the eye tube, and close to the optical axis and focus of the objective. The light from this artificial star passes through the tube to and through the object glass, then on to the collimating mirror, which should be as flat as possible. From the mirror the light returns to all portions of the objective in parallel rays. There must, however, be a little offset, so that the returning light from the star will not fall on the minute lens where the star was first formed, but the deviation from the true optical axis is but a mere trifle. Of course it would be almost impossible to secure perfect definition under these circumstances with a very large glass, as the combined errors or imperfections are made to appear twice as great as they really are, from the fact that the light has passed both ways through the objective, so that the imperfections in the material, that is the glass itself, and workmanship also, are made to appear double what they will be when used as a telescope for viewing celestial objects direct. Nor is this all, for we have the imperfections of the mirror to contend with, and who can conceive of a mirror of five or six feet in diameter resting on its edge, being perfectly symmetrical. You may think it strange if I say that while I should much prefer to have everything perfectly correct for this work, I believe it impossible, and we must do the best we can under the existing circumstances. I remember a time when a distinguished professor was shown by my father our apparatus and methods of testing lenses. The professor asked, Which are you testing, the mirror or the objective? My father's reply was, we are testing both, and surely we can test both by the method used.

After observing all the appearances in one position, the next thing to be done is to give the whole or combined glass, that is the crown and flint together, a partial turn. If appearances are changed, it is certain there is some error in the objective, for if the glass worked perfectly, no matter what imperfections were in the mirror, they would be the same whichever way you turn the objective. Having ascertained that the combined glass is not round, or rather does not give a round image of a star a little out of focus, the next thing is to locate the error or errors. Are they in the crown or flint lens? Probably in both. This is, however, ascertained by first revolving one glass. If an irregularity is detected that rotates with the glass, it must be corrected by skillfully working the surfaces, so that the portions that are of short focus shall be lengthened and those of long focus shortened until the rays shall come together at the general focus. After having rounded this lens so that no apparent change is visible by rotation, this glass must remain fixed, and the other must be examined and worked in the same manner. This work having been carefully carried out on both crown and flint lens, they are surely round, though they may not give a round image from the mirror. After the glass is rounded, the mirror itself may be corrected in the same way, but this is not absolutely necessary, as we already know the errors. This rounding of a large glass is very laborious, and sometimes requires months to accomplish. Yet the party that is to make great telescopes in the future, as well as the present, should in my opinion make himself familiar with all these tests, and have the ability to work out the errors that I have described, together with those that may arise from concentric rings of different foci.

Having stated my ideas as to the necessary requirements to make large telescopes, I will now call your attention to my idea of the great telescope itself. As before stated, I am of the opinion that it will be a refractor, and that its size will progressively increase. It will be mounted equatorially, and provided with the best driving clock that can be devised. I am in favor of the long polar axis, known as the English plan, for such an instrument, my reasons being, first, that a large driving wheel may be applied without setting the telescope to one side of the axis. The polar axis itself may also be braced in any or all directions, without interfering with, or obstructing anything. This axis can be made exceedingly stiff by bracing, and the tube itself can be braced to the axis in any position. Such mounting could be easily provided with all the clamps and slow motions that are needed. To make it all complete, we should have two telescopes, one for visual and the other for photographic work, so hung on trunnions as to counterpoise one another, thus requiring very little or no extra weight. I think an instrument mounted in this way would be much more stable than the style Americans have generally adopted in the case of great telescopes.

Now that I have spoken so favorably of these instruments, I must say in conclusion that very much will depend on the localities in which they are placed. To insure the best results, the best places should be selected as the result of thorough preliminary examinations. Doubtless there are many places, both at ordinary and high altitudes, of fine atmospheric conditions. A great telescope, even when used under ordinary circumstances, must be productive of great results, but under the very best conditions of still greater. The increase in size of even our present great refractors is not a possibility but a fact, and with this will come large acquisitions to our present stock of knowledge. The new astronomy, as well as the old, demands more power. Problems wait for their solution, and theories to be substantiated or disproved. The horizon of science has been greatly broadened within the last few years, but out upon the borderland I see the glimmer of new lights which wait for their interpretation, and the great telescopes of the future must be their interpreters.

A FIELD FOR WOMAN'S WORK IN ASTRONOMY.*

By Mrs. M. FLEMING.

IN the earliest records of ancient Greek history we can trace the great interest which centers in the heavenly bodies, and in astronomy, the greatest of all sciences, but in no way do we find women connected with the study of this science until a comparatively recent date. Caroline Herschel, Mary Somerville and Maria Mitchell were, as women, pioneers in this work. We cannot say these were the only women of their time capable of devoting themselves successfully to this work and of adding to our knowledge of the heavenly bodies and of the laws which govern them. Caroline Herschel and Maria Mitchell had rare opportunities afforded them, the former in that she had a brother who was thoroughly devoted to the work. Probably through him her interest was aroused and she became his assistant and his untiring companion in his researches. Maria Mitchell, in all likelihood, acquired a similar interest in astronomy from her father, and her high standing as an astronomer is acknowledged by all connected with the study of this science. A great many women of to-day must have a similar aptitude and taste for astronomy, and if granted similar opportunities would undoubtedly devote themselves to the work with the same untiring zeal, and thus greatly increase our knowledge of the constitution and distribution of the stars.

The United States of America is a large country, with a large-hearted and liberal-minded people. Here they have made room for comers from all other countries, have welcomed them and have given them a fair open field and equal advantages in pursuing their labors or studies, as the case may be. There is no other country in the world in which women, not as individuals, but as a class, have advanced so rapidly as in America, and there is no other country in which they enjoy the same unlimited freedom of action which affords them the opportunity to find their own level. In their studies they encounter very little narrow-mindedness or jealousy in their brother students or fellow-workers in the same field of research, but in general they are treated with the greatest courtesy, encouragement and assistance being graciously accorded. Women, therefore, who have taken up any branch of science, or indeed work of any kind, need not be discouraged in it even if one or two of the great mass which goes to make up the whole in their superior judgment refuse to give credit to their work. Labor honestly, conscientiously and steadily, and recognition and success must crown your efforts in the end.

Photography, as applied to astronomy, is one of the greatest advances which has been made in this the oldest of sciences, and this same advance has opened a comparatively extensive field for woman's work in this depar ment. Dr. Henry Draper, of New York, was the first scientist who photographed successfully the lines in a stellar spectrum. His wife, Mrs. Anna Palmer Draper, was his constant companion and assistant in all his experiments and researches. On the interruption of his valuable investigations by his sudden death in 1882, Mrs. Draper, knowing the great value of the work already done, decided that the investigations should be continued at the Harvard College Observatory under the direction of Professor Edward C. Pickering, and she set aside a liberal sum of money to be used for this work, thus founding the department known as "The Henry Draper Memorial." In 1886 there were three women computers engaged in the work in this department; at the present day there are twelve women engaged in the same or in similar work. Miss Catherine W. Bruce, of New York, has shown her appreciation of the photographic work now being carried on at the Harvard College Observatory by her generous gift to that institution of $50,000 for the erection of a photographic telescope of the largest size. The observatory has a corps of about forty assistants, seventeen of whom are women, and twelve, as stated above, are engaged more or less on the photographic work.

The photographs obtained with the various telescopes now in use at the Harvard College Observatory in Cambridge, and at the auxiliary station near Arequipa, Peru, are of various classes, the most important of these being chart plates having exposures of from ten to sixty minutes, or more, spectrum plates having exposures of from ten to sixty minutes, and trail plates having several exposures of a few seconds' duration. The women assistants are not engaged during the night in taking these photographs, but find their time during the day sufficiently occupied in examining, measuring and discussing them, and in the various computations therein involved. Catalogues, for reference, of the plates taken with each instrument have to be kept up to date, the plates have to be compared with the charts of the part of the sky which they are supposed to represent, in order to check the correctness of the record made by the observer, and to ascertain that the region intended is contained on the plate. The chart plates are then filed carefully away and are used in the confirmation of variable stars or other interesting researches. The most important work at present being done from the chart plates taken with the 8-inch Draper telescope in Cambridge, and with the 8-inch Bache telescope in Peru, is the measurement of the faint stars for standards of stellar magnitudes. These measurements of about forty thousand stars are now being made by Miss Eva F. Leland. She is also engaged in the measurements of the brightness of the stars in clusters. Miss Louisa D. Wells and Miss Mabel C. Stevens have shown great skill and accuracy in making the identification of stars shown in the photographs with those contained in existing catalogues. The photographs of stellar spectra are all carefully examined in order to detect new objects of interest, such as third type stars, fourth type stars, fifth type stars, or those whose spectra consist mainly of bright lines, and similar to those discovered in Cygnus by Wolf and Rayet, planetary nebulæ, and variable stars. All of these except the first named class differ so much from the general mass of stellar spectra that a trained eye has little difficulty in detecting them on the photographic plates, even although the objects found are sometimes as faint as the ninth magnitude. If an object is detected on any of the photographs showing a spectrum of the third type, having also the hydrogen lines bright, it is at once suspected of variability, since only variables of long period are known to possess this peculiarity. The catalogues of the plates taken with the different instruments are then consulted, and a list is made of all the plates covering the region of the star suspected of variability. So you have, ready to your hand and for immediate use, the material for which a visual observer might have to wait for years and certainly for months. This material must also be considered more reliable, for in the case of a visual observer, you have simply his statement of how the object appeared at a given time as seen by him alone, while here you have a photograph in which every star speaks for itself, and which can at any time, now or in the years to come, be compared with any other photographs of the same part of the sky.

Many interesting discoveries have been made from the study of these photographs of stellar spectra. First in importance among them was the discovery that ζ Ursæ Majoris is a close binary star, the two components revolving around each other at a velocity of about a hundred miles a second, in a period of about fifty-two days. This discovery was made by Professor Edward C. Pickering, his attention being first attracted to it by the fact that in the photographs of the spectrum of this star the lines appear sometimes double and at other times single. This discovery led to the finding of a second object of this same class, β Aurigæ, by Miss Antonia C. Maury. This last star has attracted public attention much more widely than ζ Ursæ Majoris, and may be considered more interesting in that the period of revolution of the two components is only 3 days 23 hours and 36·7 minutes. ζ Ursæ Majoris and β Aurigæ are such close double stars that they could not possibly be separated visually with the most powerful instruments at present in use. A third object of this class is suspected in β Lyræ, which shows a similar change, or rather it shows a reversal in the position of the bright lines with regard to the dark lines in its photographic spectrum, that is, they apparently cross and recross each other. This is doubtless associated with the variation in the light of this star, since the period is the same for both. The examination of the photographs of the brighter stars has been made by Miss Maury, who has also been engaged on their classification. The micrometric measurements of the lines

* Read at the Congress of Astronomy and Astro-Physics, Chicago, August, 1893.

in the photographic spectra of the bright stars have been made by Miss Florence Cushman.

From the examination of the photographs of stellar spectra, thirty-eight stars having spectra of the fifth type have been added to the sixteen previously known, making the known number in all fifty-four. Three of the stars in this list have been discovered during the past few days and have not as yet been announced elsewhere. Twenty-three new variable stars have been discovered in this same examination of the photographs, and before being published each and all were confirmed by Professor Pickering. Two of the twenty-three have not yet been announced elsewhere since one of them was discovered only recently. This star is in the wonderful southern cluster ω Centauri, the finest in the sky, and being so situated would probably never have been discovered by other means than photography. The other star is in Columba and is the first variable discovered in that constellation. Its position for 1875 is in R. A. 5h. 45m. 41 9s., Dec.—29° 13·7'.

One must not always cling to the earliest method of accomplishing anything and assume that because it was the earliest and has held sway for centuries, it must consequently be the best, and also the only way. Where should we be to-day if we did not advance steadily in all things? Taking light for instance, first we have rude torches and rush lights, then candles by which the day was measured off into hours, this followed by lamp light, later by gas light, till now we have electricity to light our streets and our dwellings. And powerful as electricity is in itself for all purposes to which it has been applied, who among us can say that in it we have attained the highest degree of perfection in illumination? So it is with everything else we may take up, and so it is with astronomy. And thus while the old time astronomer clings tenaciously to his telescope for visual observations, astronomical photography is leaving him far behind and almost out of the field in many investigations which nevertheless he still continues in his own way, trying also to maintain that, as stated above, it must be the best, if not the only way. If photographic work is to be entirely ignored by the astronomers of the old school as they may be called, because, as they themselves say, they have no knowledge of photography, and not having the means at their command, do not wish to acquire a knowledge of it, what is to become of the researches planned and undertaken by the Astro-Photographic Congress of Paris, in which astronomers of all countries have united? We may safely say that the younger, more advanced guard of civilization will uphold photography and encourage it as applied to astronomy, as in other scientific researches in which it is also successfully employed.

A new variable star in the constellation Delphinus was discovered from the photographs some time ago, and was announced in the "Sidereal Messenger," vol. 10, p. 106. Two skilled visual observers undertook to observe it in order to confirm or refute its variability. One arrived at the conclusion that it was not variable, and was always about the ninth magnitude, while the other also found that the star was not variable, but according to his observations it was always about the eleventh magnitude. When they met together to discuss this difference in magnitude, they discovered that each had been observing a different star, and further, that neither of them had observed the variable. No such error could have occurred from the comparison of the photographic charts.

Unlike telescopic observations, the photographs are available always, at any time during the day or night, for consultation and examination. Therefore, while an observer with a telescope, be it even the most powerful that can be made, is at the mercy and dependent upon the state of the weather for his observations, the discussion of the photographs goes on uninterrupted and is undoubtedly much more reliable than visual work, since when a question of error in observation arises, any one interested in the research can, at any time, revise the original observation by another and independent examination of the photograph.

Given the instruments and materials required, with a knowledge of how the instrument is used, you can obtain in one night what would represent years of hard labor in visual observation, and in the necessary computation involved in reducing and charting these same observations. Even when finished the visual observer's chart may be subject to various errors in the positions or in the brightness of the stars with which he has dealt, but the photograph cannot fail to be an exact and unquestionable record which can be consulted and compared with others years hence, and thus serve to prove or disprove variations in light, changes in position, and in the case of the spectrum plates, changes, if any, in the constitution of the stars. Thus on a photographic plate, on which it has taken only a few minutes to reproduce the portion of the sky covered, you have a true chart of the stars in that part of the sky at that time, the limiting magnitude being dependent on the duration of the exposure and also on the sensitiveness of the plate used.

In a catalogue of variable stars recently published and entitled "Second Catalogue of Variable Stars," a more correct title would be "Second Catalogue of Variable Stars Discovered Visually," since in it no weight is given to photographic observations further than is necessary to enable them to swell the list of stars discovered visually. Stars discovered photographically which have been announced as variables, and have been proved beyond doubt to be variables, are here credited as "suspected."

In conclusion, while I may be thought to have strayed far afield from the subject on which I was supposed to address you here, the investigations and researches described above are those in which the women in this department are engaged, in which they are thoroughly interested, and in which they are becoming trained and competent assistants.

While we cannot maintain that in everything woman is man's equal, yet in many things her patience, perseverance, and method make her his superior. Therefore, let us hope that in astronomy, which now affords a large field for woman's work and skill, she may, as has been the case in several other sciences, at least prove herself his equal.

Harvard College Observatory, Cambridge, Mass., August 4, 1893.

PILOCARPINE: ITS PHYSIOLOGICAL ACTION AND THERAPEUTIC USES. WITH EXHIBITION OF SPECIMENS SHOWING CHANGE IN THE COLOR OF THE HAIR.*

By D. W. PRENTISS, M.D., Washington, D. C.

THE drug which I have selected to bring to your attention this evening is the most important addition to the Pharmacopœia of 1880, and is one that has interested me for several years past.

In one particular its action is unique, and is confined, so far as I know, to my own experience. I refer to the action of pilocarpine in changing the color of the hair.

This action of the drug alone, however, is too limited for general interest, and the title of the paper is made to read: "Pilocarpine: Its Physiological Action and Therapeutic Uses. With Exhibition of Specimens Showing Change in the Color of the Hair."

I am warned that this essay must not be too long, and therefore shall try to condense it as much as possible.

DIVISION OF THE SUBJECT.

1. *Brief Statement of Natural History.*
2. *Physiological Action.*
   1. As a sudorific.
   2. As a stimulant to accommodation of eye and contraction of pupil, and as stimulant to the hearing apparatus.
   3. As a stimulant to the growth of the hair—action in changing color of hair.
3. *Therapeutic Uses.*
   1. Most important as a sweat producer.
   2. In diseases of the eye and ear.
   3. Use in promoting growth of the hair.

1. *Natural History.*—(Pharmacographia) *Pilocarpus pennatifolius*, Lemaire.

A shrub, growing to height of ten feet; native of the eastern provinces of Brazil. (For plate, see Bentley and Trimen, part xxxii., 1878.)

There are other species included under the general name of jaborandi, but the *pennatifolius* is the most active and the one recognized by the United States Pharmacopœia.

The principal constituents of the leaves are:†

1. *Pilocarpine*, the active principle.
2. *Jaborine.*
3. *An essential oil*, which shows in the pellucid spots of the leaves and belongs to the terebene series.

Pilocarpine is an amorphous soft amber-colored mass, discovered in 1875 by Hardy, and makes crystallizable salts with acids. Leaves contain one-half of one per cent.

Jaborine has the same chemical constituents, but differently arranged, and gives just the opposite physiological action to pilocarpine. The action of jaborine is identical with atropine.

Hence the importance that the pilocarpine be pure and free from admixture. This admixture probably explains the different results obtained by different investigators as to physiological action.

The essential oil is inert.

2. *Physiological Action.*

1. As a sudorific.

Perhaps the shortest and least tiresome method of describing its physiological action will be to mention an actual case,‡ and as this is the case in which the change in the color of the hair occurred, it will be the more appropriate. It also illustrates the use of the drug in uræmia.

The patient, female, aged twenty-five years, was suffering from pyelo-nephritis with prolonged anuria. For ten weeks the amount of urine did not average two ounces daily, and this contained offensive pus. At one time—from December 16 to 23, seven days—not a drop was passed, although the catheter was used twice daily.

Again, from January 22 to February 2—eleven days—not a drop was excreted, the catheter still being introduced twice daily; and from January 22 to February 12—twenty-one days—a total of but little over two ounces in all were passed. Twenty-one days of almost total *anuria.*

Previous to December 16 the hot bath and hot packing were several times resorted to to produce diaphoresis, without effect.

Extreme uræmic symptoms had developed—no itching, but incessant vomiting, nervous restlessness, twitchings of the muscles, flushed face, severe headache, confusion of vision and delirium.

An attempt was made to give infusion of jaborandi by the stomach, but it was rejected, as was also the solid extract in gelatin-coated pills.

Finally, December 16, hydrochlorate of pilocarpine, 1 centigramme, was administered hypodermically, the patient being wrapped in a warm blanket, with bottles of hot water around her.

On two or three occasions later, when the blanket and hot bottles were omitted, there was less sweating.

From December 16 to February 22, twenty-two sweats were administered, requiring thirty-five or forty centigrammes of pilocarpine. As the patient became accustomed to the medicine, it was found necessary to increase the dose to two centigrammes.

An analysis of the phenomena following the use of the drug in one of these "sweats," it seems to me, will be more graphic than a general description of the physiological action. If it is tiresome, I crave pardon. It shall, at least, be brief.

A Pilocarpine Sweat, 1 Centigramme Hypodermically.—The action of the drug was carefully noted. Immediately, almost before the needle was withdrawn, the face and neck would flush bright red, and dimness of vision be noticed; then palpitation. In three minutes slight nausea; eyes, nose and mouth beginning to water, and skin showing moisture. In seven minutes free vomiting, profuse sweating and salivation.

ANALYSIS OF SEPARATE SYMPTOMS.

Perspiration.—First noticed on forehead and neck, then the skin of the whole body, which had been previously dry and harsh, became moist. When sweating was fully established the water ran in little streams over all parts of the body. In the face it was with difficulty kept out of the eyes. In five minutes the hair would be saturated, and though wiped as dry as possible, it would be again soaked in a few minutes. In odor the perspiration was offensive, and on several occasions had a distinctly urinous smell.

Salivary Glands.—In the beginning of the ordeal water flowed freely from the eyes and nose, as well as from the mouth, but when salivation was fully established, the eyes and nose ceased to discharge. The saliva was viscid and tenacious, so that to clear the mouth it was necessary to use a handkerchief. Its flow was so profuse that, after thus clearing the mouth, she would not have time to get a drink to quench thirst before the mouth would again be filled. So, also, talking connectedly was prevented by the same cause. The water drank during a sweat at no time exceeded a gobletful.

Vomiting.—The vomiting continued throughout, almost without intermission, and was the most distressing symptom of the ordeal. After a spell of vomiting, the patient would lie back on the pillow exhausted, hoping for a rest, but it would immediately return. The odor of the ejecta during February was very offensive, like decayed vegetable matter.

The amount discharged in this way, which included saliva, was never less than two quarts, and often a gallon. The patient stated that she did not swallow the saliva, and insisted that the material vomited came from the stomach. This would indicate that pilocarpine also causes a fluid discharge from the gastric mucous membrane. Nausea and vomiting ceased as soon as the effect of the medicine passed off. Food was then taken and retained, although previously the stomach rejected everything.

Bowels.—Just as soon as perspiration was fully established the bowels moved—always a large action, and sometimes more than once. This action on the bowels is twofold: (1) from an increased amount of liquid in the intestines, and (2) from increase of peristaltic action. There were seldom more than two or three movements.

Action on Heart.—Pulse became rapid in a few minutes, and when the action of the drug was fully established, a thumping palpitation added to the distress occasioned by the vomiting. This "thumping" could be heard at a distance of six feet, and continued with decreasing violence until the close of the paroxysm. The pulse ranged from 120 to 136, and was weak and compressible.

Eyes.—Pupils contracted to a small point. Sight became impaired at the first rush of blood to the face, and the dimness continued until it was impossible to distinguish objects beyond the foot of the bed.

As the effects wore off the exhaustion was extreme; pulse 130 and feeble. But there was a grateful sense of relief, and a disposition to sleep even before the sweating ceased. The head was no longer dizzy, pain less, stomach free from nausea, and tongue free from coating. A quiet sleep followed, lasting several hours, from which the patient awakened refreshed and hungry.

Amount of Fluid Discharged During a Sweat.—Of course, this could only be estimated. The fluids from acts of vomiting were caught in a basin and emptied three or four times, and each time contained not less than a quart. The blanket in which the patient was wrapped was saturated, as was also a folded sheet under the blanket. The pillow was saturated and the bolster beneath wet.

An experiment was made of saturating the blanket to as near as possible the same extent, and five pints of water were required.

Putting these together, then, we have the following calculation:

	Pints.
By vomiting and saliva	7
By saturated blanket	5
By sheet, pillow and body clothing	2
	14

This seems almost incredible, but I believe the amount is strictly within the truth. The patient and her attendants thought the amount understated rather than exaggerated.

It is unnecessary to record further the details of this case, as I have used it in illustration of the action of pilocarpine.

Suffice it to say, the patient recovered, and is alive to-day.

It only remains in this case to record the remarkable change in the color of the hair which took place under the influence of the pilocarpine.

All of the patient's life (she was twenty-five years old) up to the beginning of the treatment her hair was light blonde with a yellow tinge. Twelve days after beginning the injections it was noticed to be darker, and from that time the change of color was rapid, until, two months later, it was black.*

The hair also become coarser and thicker in its growth. The eyebrows and eyelashes, before almost invisible, came out beautifully penciled. The hair on other portions of the body participated in the change.

MODUS OPERANDI OF PILOCARPINE.

Upon sweat and salivary glands:

1. Stimulates nerve centers of these glands.
2. Stimulates efferent nerves to the glands.
3. Stimulates glandular structure itself to increase the secretion.

In brief, pilocarpine is a specific diaphoretic and sialagogue by its elective action on these glands.

It increases also the secretions from the mucous membranes of the

Bronchial tubes,
Stomach,
Intestines and kidneys,
But does not increase the flow of bile.

As to the discharge from the bronchi, stomach and intestines, it is difficult to say how much of the liquid is swallowed saliva.

There is not time in this paper to go into details of the experiments made to show the manner of the action of this drug, nor is it necessary, since they are fully discussed in the works of H. C. Wood, Lauder Brunton, Ringer and others.

* Read before the New York Academy of Medicine by invitation, April 5, 1893.—*Therapeutic Gazette.*

† Through the kindness of Merck & Co., of New York, specimens of the pure alkaloids and their salts were exhibited.

‡ *Philadelphia Medical Times*, July 2, 1881.

* Specimens were exhibited showing changes as above described.

Brunton speaks of the enormous secretion from the sweat glands, and states that it amounts to from one to two pounds, and together with the salivary secretion, often as much as eight pounds.

In the case which I have mentioned above I have estimated the amount, including the vomiting, at fourteen pounds.

I expect to have this statement challenged, and admit that it appears incredible that a girl weighing ninety or one hundred pounds could thus lose one-fifth of her weight in six hours without serious consequences. But the estimate was honestly made, and I stand by it.

Landois and Sterling give the amount of blood in the body at one-thirteenth of the body weight, and the total proportion of water to the weight of the body at 58·5 per cent.

It is not to be supposed that all the water excreted during a pilocarpine sweat comes from the blood at one time. As it is taken out of the blood it is replaced from other tissues by reabsorption.

One important point in the diaphoretic action of pilocarpine is the fact that the amount of urea excreted by the skin is greatly increased. This amount is stated to be not less than one gramme (fifteen grains) for each "sweat," which is five times more than in normal perspiration (H. C. Wood).

The importance of this fact is recognized in the usefulness of pilocarpine in uræmia, and is markedly illustrated in the above case. After three or four days of anuria, uræmic symptoms became intense, and were relieved by pilocarpine.

The discharge from the bronchial mucous membrane is largely increased. This also has an important clinical significance in two ways:

1. It is this effect that makes it useful in the treatment of diphtheria, in which disease it detaches and softens the membranes by the liquid exudation beneath them, so that they can be expelled. This statement is not theoretical, but is a clinical fact, and were it not for the depressing action of the drug on the heart, it would undoubtedly be of great value in that disease.

2. The second clinical significance of this action on the bronchial mucous membrane is that it points out a contraindication, as in cases where bronchitis or œdema of the lungs exists there is danger of drowning the patient in his own secretions.

But whatever may be the physiological action, as shown by experiments on animals, the clinical effect on the heart constitutes the main contraindication and principal danger of its use in disease. Many cases have occurred where fatal results from cardiac failure have followed its use in disease.

One notable case occurred in Dublin, Ireland, some years since, where a physician administered pilocarpine in malignant scarlatina. The patient promptly died, and the doctor was called upon to defend an action at law for having killed the child.

A similar case came under my own observation, without, however, the unpleasant sequel.

So, also, in dropsy with weak heart, especially dropsy due to heart disease, care must be taken, in the use of the remedy, to administer stimulants freely at the same time.

Action on respiration follows that on the heart, dyspnœa accompanying the intense palpitation, and later there may be embarrassment from accumulation of mucus in the bronchial tubes. Temperature falls 0·9° during sweating stage (Brunton).

Another action of pilocarpine, which is mentioned only as a caution, is its effect in producing abortion. This is a frequent result where given in full dose during pregnancy. In like manner, also, it may produce premature menstruation or precipitate menorrhagia. Bartholow mentions four cases in which labor was induced by three hypodermic injections of two centigrammes each; and out of nine cases where it was used for this purpose, it was successful in six.

(To be continued.)

A SIMPLE METHOD OF STERILIZING WATER FOR DOMESTIC PURPOSES.

By FRANCIS WATTS, F.I.C., Analyst to the Government of the Leeward Islands.

SOME time ago it became necessary to devise a process for the removal of suspended finely divided particles of clay from water, for a delicate technical process. Considerable difficulty was experienced in rendering the water quite bright; some of the finer particles of clay remaining suspended rendered the water opalescent, and such forms of filter as could be used failed to remove this opalescence. It occurred to me to experiment with various precipitates which could be produced in the water and carry down with them these troublesome particles. Finally, the formation of aluminum hydrate was decided upon, and this was accomplished by adding alum, or some other suitable aluminum salt, in small quantities to the water and precipitating with lime water. The precipitate was allowed to subside and the water drawn off. The most troublesome waters were found to be rendered quite bright by this treatment.

Subsequently, the problem of purifying considerable quantities of water for drinking purposes was presented to me, when it appeared reasonable to suppose that if the fine particles of clay were removed by the aluminum hydrate, other minute bodies, and among them any micro-organisms that happened to be present, would be largely removed also. But in this case the use of ferric hydrate suggested itself, on account of the readiness with which it parts with its oxygen to organic matter, it being thought that some additional purifying effect would be derived from this.

Experiments were undertaken to ascertain the effect upon the micro-organisms of precipitating ferric hydrate in the water in question. The water being a moderately hard one, merely required the addition of a small quantity of a nearly saturated solution of ferric chloride for a precipitate to form; this was filtered through sterilized filter paper, and small quantities of the water introduced into nutrient solutions. In practically every case, no development of micro-organisms took place, even when the solutions were kept for over a week. Similar tubes were treated with the water before the addition of the iron solution, and growth in every case followed in eighteen hours.

These experiments have been repeated at intervals over a period of two years, and always with the same results. Even when small quantities of water are drawn from the mass in which the ferric hydrate has subsided, without filtration, the supernatant water appears to be sterile.

It would appear, then, that we have here a simple process for rendering water for drinking and domestic purposes sterile with but little trouble or loss of time, and that this process will render water as completely sterile as boiling will. Boiling water for drinking purposes is always a troublesome operation; the quantity to be operated upon is usually greater than can be dealt with conveniently; a considerable time elapses before it is fit for use, and, when ready, the flat, mawkish taste is objectionable; in fact the operation is rarely faithfully carried out, save in time of panic.

To carry out the process suggested in the case of a hard water, it suffices to add sufficient solution of ferric chloride (which should be as nearly neutral as possible) to produce a perceptible precipitate, the carbonates dissolved in the water being in many cases sufficient to effect this. In the case of a soft water—*i. e.*, one in which no precipitate is produced on the addition of ferric chloride, after the ferric chloride is added—a small quantity of lime water, or of dilute solution of carbonate of soda, is thrown in, and this causes a precipitate to form. It is found that vigorous stirring promotes the granulation and subsidence of the precipitate.

The precipitate is allowed to subside, and the clear water is drawn off for use. It is often preferable to pass the water through some simple form of filter, such as a felt bag, or through clean sand placed in a shallow box, or in a flower pot, in order to keep back any particles of the precipitate which may have been disturbed in the operation of drawing the water; but with large quantities of water this is seldom necessary.

It is found that 1 to 1½ fluid ounces of strong solution of perchloride of iron (British Pharmacopœia strength) are sufficient to purify 100 gallons of water. For domestic use it is advisable to dilute the solution considerably, say 10 times, and to use a teaspoonful of the diluted solution for each gallon of water.

If a sufficient quantity of water for one day's use be treated at night, a supply of pure water will then be ready for use every morning, with a very moderate expenditure of trouble or money.

With prevalence of diseases capable of being spread by the use of polluted drinking water, it would seem worth while to make a trial of a process which appears at once efficient, inexpensive, and equally applicable to large or small quantities of water.

A memorandum of this process was published in the *Official Gazette of the Leeward Islands*, xviii., No. 48, November 27, 1890, since which time the process has been employed in public institutions and private houses in this colony, with apparently good results. It would at least be interesting if others repeated these experiments with a view to their correction or confirmation.

LIQUID AND SOLID AIR.

By JOHN S. MCKAY, Packer Institute, Brooklyn, N. Y.

THE physical state or condition of a body is entirely incidental and never dependent upon any inherent property. The same substance may be solid in one zone and liquid or gaseous in another. According to the kinetic theory, the different states of matter are only different modes of molecular motion and any change of state is the result of the absorption or liberation of energy. By the addition of sufficient heat energy all solids and liquids become gases, and by withdrawing such energy all gases may be reduced to the liquid or solid state. It is probable that at the temperature of absolute zero (—273° C.) there would be neither solid nor fluid, but that if matter still continued to manifest itself to our senses, it would be in a different physical form from anything now known. It is certain that there could be no gases at that temperature, since molecular motion is essential to the idea of gaseity. From recent experiments it seems probable that all gases under ordinary atmospheric pressure would become liquid or solid before reaching absolute zero. It is a well-known fact that after a gas has been cooled below its critical temperature it may be reduced to the liquid state by the aid of external pressure. Until a few years ago oxygen, hydrogen, nitrogen, air and a few other gases had never been reduced to their critical temperatures, and hence could not be liquefied. Air had been compressed until it was denser than water without any trace of liquefaction. And so these gases were called permanent or incoercible gases. But in 1879 Cailletet, of Paris, and Pictet, of Geneva, working independently and by somewhat different methods, succeeded in reaching the critical temperature of some of these gases and by great pressure reduced them to the liquid form. Since then all known gases have been liquefied and the old distinction of permanent and coercible gases has been effaced.

The critical temperature or absolute boiling point of these gases is very low, being —140° C. for oxygen, —146° C. for nitrogen and —240° C. for hydrogen. This low temperature is obtained by evaporating in vacuo liquid NO, CO_2, SO_2, or some other substance whose critical temperature is comparatively high and which is, therefore, easily liquefied. As yet hydrogen has been liquefied only in small quantities by allowing it to expand suddenly when at a low temperature and highly compressed. In some remarkable experiments before the Royal Society of London during the past year, Prof. Dewar made use of liquid ethylene to secure the low temperature necessary to liquefy air and oxygen. By means of three concentric vessels, the outer one containing liquid nitrous oxide and the next one liquid ethylene, both being connected with powerful vacuum pumps to increase the evaporation, he secured so low a temperature in the inner vessel that oxygen, nitrogen and air were liquefied in large quantities with comparatively little pressure. By causing a vacuum to act upon a large tube containing liquid oxygen, a temperature of —210° C. was produced. A small empty test tube inserted into the boiling oxygen was so cold that the air of the room at ordinary pressure condensed and trickled down its sides. By evaporating liquid nitrogen in a vacuum a temperature of —225° C. was reached, at which point nitrogen became solid.

Liquid oxygen when first formed is milky in appearance, owing to the presence of some impurity, which may be removed by passing it through ordinary filter paper. When pure it is of a pale blue color, which, however, is not due, as some have thought, to the presence of liquid ozone, which is of a dark blue color. Liquid oxygen is a non-conductor of electricity, but is strongly magnetic. It may be lifted from a cup by presenting the poles of a strong electro-magnet. It seems to have very slight chemical activity, since it will extinguish a lighted match and has no action on a piece of phosphorus dropped into it. It is well known that the A and B lines of the solar spectrum are due to oxygen, and, from recent experiments on the top of Mont Blanc, it is thought that they are largely, if not wholly, due to the oxygen in the earth's atmosphere. Prof. Dewar showed that these lines come out very strong when liquid oxygen is interposed in the path of the rays from an electric lamp.

Liquid air is at first somewhat opalescent, owing probably to solid particles of carbon dioxide. It may be cleared by filtering or by standing for a few minutes, when the particles rise and disappear. When any of these liquefied gases are placed in an ordinary glass vessel they boil vigorously and soon disappear, owing to the heat obtained from the vessel and surrounding objects. In a vessel made of rock salt they take the spheroidal form and last much longer, but Prof. Dewar found that they could be kept longest in vessels with double walls with high vacua between them. A small bulb filled with liquid air and protected by a vacuum would require an hour and a half to boil away—five times as long as it could be kept in an ordinary vessel. Liquid air has the same high insulating power as oxygen, but it is less magnetic. Its magnetic power is evidently due to the oxygen, since liquid nitrogen is not magnetic. When the oxygen is attracted by a magnet it draws the inert nitrogen along with it without being separated, but if a sponge or ball of cotton be saturated with liquid oxygen and presented to a magnet, the liquid will be drawn out of the meshes and cling to the magnet until it evaporates. The normal boiling point of nitrogen is about eight degrees below that of oxygen, so that the two substances may be separated by distillation, the nitrogen boiling off first and leaving the oxygen. But when air is being liquefied the nitrogen does not come down first, as might be expected, but the two condense together at a temperature about midway between their respective boiling points.

All the liquefied gases except oxygen and hydrogen have been frozen by self-evaporation in a vacuum. By evaporating liquid air in a vessel surrounded by liquid oxygen, Prof. Dewar succeeded in reducing the air to a clear transparent solid. It has not yet been determined whether the oxygen of the mixture is really frozen or merely entangled among the particles of solid nitrogen in some such way as rose water in cold cream or water in the solid gelatin of calves' foot jelly. Although pure oxygen has never been frozen, it is possible that when mixed with nitrogen its freezing point is raised so that the two solidify together.

One of the interesting things connected with these recent experiments in the liquefaction of gases is the fact that it enables us to produce a lower temperature than ever before. We are slowly creeping down toward the absolute zero and the possible solution of the mysteries connected with the nature and constitution of matter. Is it not possible that we may yet be able to separate matter from energy and thus form some conception of matter pure and simple? When the molecules cease to vibrate what would be the state or condition of matter? Would it still manifest itself to the senses? If so, what properties would it retain, what new ones acquire?—*Science.*

SILICIDE OF CARBON.

SILICIDE of carbon, CSi, has been obtained by M. Moissan in beautiful large crystals very similar in appearance to sapphires and considerably harder than rubies, by four different processes involving the use of his recently described electric furnace. *Nature* says: The existence of this curious compound of two closely allied elements was first pointed out by M. Colson, who obtained it in the amorphous form by heating crystals of silicon in a current of hydrogen charged with vapor of benzene. Some years ago M. Moissan obtained it, in the condition of crystals several millimeters in length, by dissolving carbon in silicon, the latter being maintained in a state of fusion by means of a small but powerful blast furnace. The crystals were isolated from the excess of silicon by treating the product with a boiling mixture of nitric and hydrofluoric acid. M. Moissan now shows, however, that crystallized silicide of carbon may be much more readily prepared by heating a mixture of carbon and silicon, in the proportions of their atomic weights, in the electric furnace. The mass of crystals produced during the passage of the current may be purified by boiling first in the acid mixture above mentioned, and subsequently in an oxidizing mixture of nitric acid and potassium chlorate. The crystals produced by this simple method are most frequently yellow, but are quite transparent if the operation is performed rapidly in a closed crucible of carbon, and provided the silicon employed is free from iron. Sometimes, however, the crystals are colored blue, and closely resemble sapphires. The second process for the preparation of the compound consists in heating in the electric furnace a mixture of iron silicon and carbon, or more simply of iron silica and carbon; a regulus of metallic iron containing large crystals of silicide of carbon is produced. The third process consists in reducing silica by means of carbon in the crucible of the electric furnace, and this mode of preparation possesses the advantage of furnishing crystals which are more nearly colorless than those produced by the first two methods, inasmuch as the silica and carbon can be employed in a fairly pure state. Perhaps the most interesting of all the methods of preparation is the fourth, in which the compound is formed by direct synthesis by the union of vapor of carbon with vapor of silicon. For, as has been previously described in these columns, M. Moissan is able to actually distill carbon at the high temperature of the arc which he is able to produce in his furnace. The experiment is

conducted in a small crucible of pure carbon of elongated form, and inclosing a little block of silicon. The base of the crucible is arranged so as to occupy the position where the highest temperature of the arc is attained, and after the conclusion of the experiment the interior of the crucible is found to be covered with almost colorless prismatic needles of carbon silicide.

Crystallized carbon silicide is an extremely stable substance which resists the action of the most energetic reagents, even those which are capable of readily attacking its elementary constituents. The pure crystals are colorless and perfectly transparent, and present the appearance of regular hexagons. The density is 3·12, and they are so hard that the ruby is readily scratched, and may be ground by means of the powdered compound. They are unalterable in air or sulphur vapor at 1,000°. Chlorine attacks them very slowly at 600°, but more rapidly at 1,200°. Fused niter and potassium chlorate are entirely without action upon them, as are likewise boiling sulphuric, hydrochloric, and nitric acids, and even *aqua regia* and the silicon-dissolving mixture of nitric and hydrofluoric acids are incapable of attacking them. Fused caustic potash, however, after heating to redness for an hour in contact with them, reacts with formation of carbonate and silicate of potassium, and thus affords a means of estimating the content of silicon. The carbon may also be estimated by repeated combustion with chromate of lead, which gradually effects oxidation of the carbon. The analyses thus carried out agree in all cases with the simple formula CSi.

NITRO-METALS, A NEW SERIES OF COMPOUNDS OF METALS WITH NITROGEN PEROXIDE.

A REMARKABLE new series of compounds, formed by the direct union of nitrogen peroxide with certain metals, and of a nature somewhat akin to that of the metallic carbonyls recently discovered and investigated by Mr. Mond and his co-workers, are described by MM. Sabatier and Senderens in the September number of the *Bulletin de la Societe Chemique*. It was observed that when vapor of peroxide of nitrogen in a state of tolerable purity was allowed to stream at the ordinary temperature over metallic copper, cobalt, nickel, or iron, these metals being in the finely divided and pure condition obtained by the recent reduction of their oxides by hydrogen, rapid absorption of the nitrogen peroxide occurred, with the formation of definite compounds possessing properties of an exceptionally interesting kind. These compounds are solid non-volatile substances, unlike the metallic carbonyls in this respect, and are represented by the general formula M_xNO_2, where M represents either of the four metals mentioned. Their discoverers propose the name *metaux nitres*, which perhaps may be conveniently rendered into English as *nitro-metals*.

When a quantity of copper, recently prepared by the reduction of copper oxide in the usual manner by means of a stream of hydrogen or of carbon monoxide, is exposed at the ordinary summer temperature (about 25° being the average temperature of the laboratory while MM. Sabatier and Senderens were conducting these experiments) to a current of the reddish brown vapor of nitrogen peroxide, it becomes rapidly attacked and converted into a brown substance, considerable heat being at the same time evolved and a large proportion of the nitrogen peroxide absorbed. The brown solid substance produced is found to react with great energy with water, the reaction being accompanied by a copious evolution of nitric oxide, NO. At 30° reduced copper absorbs no less than a thousand times its volume of nitrogen peroxide. Upon analysis of the product it is found to contain about 74 per cent. of copper. A compound of the composition Cu_2NO_2 would contain 73·4 per cent. The nitrogen present was also determined directly, by heating with excess of copper in a stream of carbon dioxide, the nitrogen being measured over caustic potash in the ordinary manner; its amount was found to correspond closely with that demanded by the above formula.

In preparing nitro-copper care must be taken to free the nitrogen peroxide from traces of the vapor of nitric acid, for this acid decomposes the compound with energy, effervescence occurring and the green nitrate of copper being produced. To prevent the deleterious effects of traces of admixed nitric acid vapor, the red fumes are allowed to pass first through a column of litharge and afterward over phosphoric anhydride.

Nitro-copper is unalterable in dry air at ordinary atmospheric temperatures. When heated in pure nitrogen it is dissociated, a temperature of 90° being ample to effect the change; nitrogen peroxide is evolved, together with smaller quantities of nitric oxide and nitrogen, and partially oxidized-copper remains. One of the most useful properties of nitro-copper is that it may be used for the purpose of liquefying nitrogen peroxide; if a quantity is placed in one limb of a Faraday V tube and heated, the other limb being cooled, the nitrogen peroxide liberated by the dissociation rapidly collects in the liquid form in the cold limb. If the tube is removed and allowed to stand a short time, reabsorption of the peroxide by the copper occurs. Water reacts with nitro-copper as above mentioned with considerable violence, pure nitric oxide entirely soluble in solution of ferrous sulphate being briskly evolved. The aqueous solution contains cupric nitrate and nitrite, and a sediment of pure copper remains. In moist air, therefore, nitro-copper rapidly deteriorates, becoming enveloped in red fumes and its surface turning green. Hydrogen is without action upon it in the cold, but when heated to 180° large quantities of ammonium nitrite and free ammonia are produced. Dry ammonia gas reacts at the ordinary temperature with some energy upon nitro-copper. White clouds of ammonia nitrate and nitrite and of moisture first make their appearance, then suddenly the mass becomes incandescent and more copious clouds of ammoniacal salts and steam are produced, the residue consisting of copper mixed with ammoniacal oxide of copper. Sulphureted hydrogen likewise reacts at the ordinary temperature with nitro-copper, heat being evolved, water, sulphur, and a blue sulphide of copper being the products of the reaction.

It would thus appear that nitro-copper is of a kindred nature to the metallic carbonyls, the nitrogen peroxide being held in a similar manner to the carbon monoxide of the latter compounds, and capable of being liberated in a regular manner by the dissociation of the compound by heat. The substance may, in fact, be employed as a convenient means of storing nitrogen peroxide, with the certainty of being able to liberate it by a comparatively slight rise of temperature whenever it is desired to procure some for experimental purposes.

Metallic cobalt reduced from its oxide by means of hydrogen at a temperature below redness is only difficultly pyrophoric in air, not becoming incandescent on admission into air with anything like the readiness of iron. It burns energetically in the cold, however, in nitrogen peroxide. When the nitrogen peroxide vapor is diluted with nitrogen, the heat of the reaction is modified, and the formation of nitro-cobalt occurs in a regular manner, as in the case of copper. It is necessary in the case of cobalt to conduct the preliminary reduction in hydrogen in the same tube as is afterward used for the preparation of the nitro-compound, in order to avoid reoxidation of the metal, and it is advantageous to employ as low a temperature for the reduction as possible.

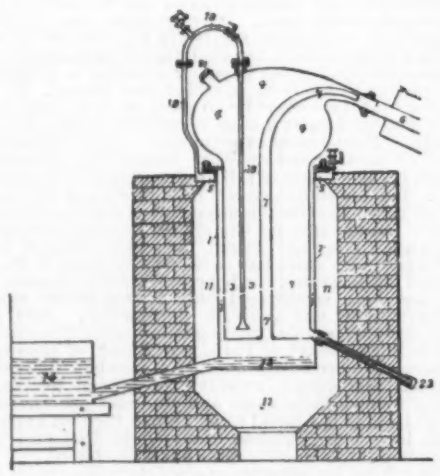
Nitro-cobalt is a black solid substance. Its reaction with water is very violent, but less nitric oxide is produced than in the case of nitro-copper. The rose-colored solution contains mainly nitrate of cobalt, and a quantity of basic nitrite is found among the residual copper. When nitro-cobalt is heated in an atmosphere of nitrogen, a small quantity of nitrous fumes are first evolved, then almost immediately violent deflagration, accompanied by a flame of great brilliance, occurs. The same explosive deflagration occurs if, at the end of the preparation, the supply of diluting nitrogen is shut off before the nitrogen peroxide. When mixed with a combustible substance, nitro-cobalt forms a dangerous explosive. If a small quantity wrapped in paper is introduced into an eprouvette filled with mercury at the top of which is a little water, a violent explosion at once results upon the arrival of the small paper packet at the surface of the mercury, owing presumably to the heat of the reaction of a portion of the nitro-cobalt with water causing sudden dissociation of the whole, the organic matter of the paper burning in the gaseous products of the dissociation.

Nitro-nickel is more difficult to obtain in a pure state, for cold reduced nickel reacts so vigorously with nitrogen peroxide that even when the latter is largely diluted with nitrogen a partial oxidation of the metal occurs. Actual incandescent combustion is, however, avoided, and a regular absorption of the peroxide vapor occurs. In a careful experiment a product containing 20 per cent. of NO_2 instead of the theoretical 28 per cent. was obtained. Nitro-nickel closely resembles nitro-cobalt; it is a black substance which reacts with water with evolution of nitric oxide, and which deflagrates with explosive force when heated in a current of inert gas.

Nitro-iron is still more difficult to isolate. When the peroxide is diluted with a very large excess of nitrogen, it is quickly absorbed by reduced iron up to a certain point, when the passage of more peroxide invariably brings about brilliant deflagration and consequent destruction of the product. There is ample evidence, however, that iron does form a nitro-compound of a similar interesting nature to that of the nitro-compounds of copper, cobalt, and nickel above described.—*A. E. Tutton, in Nature.*

AN IMPROVED ALEMBIC.

THE alembic, the subject of the present invention by V. J. Kness and C. H. J. Donnadieu, Paris, is used for the distillation of matters by means of a steam bath and may be constructed as indicated in the illustration.



IMPROVED ALEMBIC.

The alembic 3 is placed within the water vessel 1 in which the water level 12 is maintained constant by connection with an outside supply cistern 14. The whole is inserted in the furnace 11. The alembic carries a central vertical taper tube 7, bent in such a way as to enter the inner opening of the discharge tube which leads from the head 4 to the condenser 6. As steam is raised in the vessel 1 it not only heats the contents of the vessel 3, but, escaping through the tube 7, acts as an ejector for the vapors arising from the matters to be distilled, thereby facilitating the operation. In order to further accelerate this, a second water receptacle 5 may be fitted around the alembic at the top of the furnace and the steam produced therein allowed to descend through the distillate by the pipe 18, thence escaping, together with the vapor, through the common discharge pipe.

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